SCIENTIFIC AMERICAN SUPPLEMENT, No. 1010

Copyright, 1895, by Munn & Co.

Scientific American Supplement, Vol. XXXIX. No. 1010. Scientific American, established 1845. NEW YORK, MAY 11, 1895. Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

EXTENSION OF THE PARIS-SCEAUX RAILWAY.

THE line from Paris to Sceaux, established by Engineer Arnoux, in 1846, is well known to all Parisians and their guests. This line of 5·75 ft. gage, provided with special rolling stock capable of turning in curves of very feeble radius, did duty for the charming suburbs in which are situated Bourg-la-Reine, Sceaux, Fontenay-aux-Roses, Limours, and Orsay.

The traffic of this small line having become relatively large, and the rolling stock considerably deteriorated, the Orleans Company, to which the railway belongs, decided upon a new direction line that should suppress the curves of very feeble radius, and in which the tracks should be brought to the normal gage.

Then, as the terminus of the line was very distant, at Denfert-Rochereau Place, it was resolved to prolong the line to Medicis Place, at the summit of Boulevard Saint Michel. This project was the object of a decree of public utility at the date of December 14, 1889.

The work is now finished. It was executed without ever completely interrupting the running upon the tracks, under which extends the new railway. It does genuine honor to the engineers who studied and brought it to completion, especially to Mr. De la Brosse, government engineer. Let us pass in review the different phases of construction.

The Direction Line.—As shown in Fig. 3, the new line starts from the old Sceaux station, called Denfert-Rochereau station. At first in the open air, it soon enters a cutting and then a tunnel, which, with stairways here and there, runs under Denfert-Rochereau Street, Observatory Avenue and Boulevard Saint Michel as far as to Medicis Place. The total length is about 5,500 ft.

The line is systematically sunk in the ground, so as to be 35 ft. beneath the roadway at Medicis Place. This sinking was done with a view to the permitting of a future connection of the line with the extension of other urban lines already begun, which, as a whole, will constitute the beginning of the metropolitan railway so ardently wished for at Paris and always adjourned.

The Stations.—The line comprises three stations in all; one the old Sceaux or Denfert station, an intermediate one called the Port Royal station, and, finally, the Luxembourg, or terminal station, at Medicis Place. The architecture of these three stations is light and graceful. In them iron was employed concurrently with wood, so as to avoid heaviness of aspect. Here we really have the stations of a metropolitan line, with wide and easy approaches, that permit the public to go up and down with scarcely any exertion.

At the Luxembourg station the walls are faced with bricks and porcelain tiles of dazzling whiteness. This facing, without extraordinary or exaggerated expense, offers numerous advantages: In the first place, from the standpoint of hygiene, since these polished surfaces are very easily cleaned, and, secondly, from the standpoint of lighting. It is hardly necessary to say that the tunnel will be lighted with electricity, and the reflection of the light from these white walls will, according to the experiments that have been made, greatly contribute toward the illumination of the tracks and platforms.

The Work.—The construction of this short line had the advantage of being performed in an elevated part of the city, and, consequently, in dry ground, save for a few adventive sub-infiltrations; but it had the inconvenience of being done under roads upon which numerous carriages and street cars were constantly passing, and above the catacombs of Paris, which honeycomb this quarter in every direction.

The ceiling of the ancient quarries or catacombs varies from 38 to 70 ft. beneath the rails. In the parts where the ceiling was found to be firm and resting upon solid filling, one was content to build a wall throughout the height of the quarry as a prolongation of the archbutment of the arch. In the doubtful parts, shafts were sunk and lined with masonry, and descended like true piers to the bottom of the quarry.

As regards the arch, as shown in our engraving, a sure and rapid method was employed that permitted on the one hand of the construction without any interruption of the traffic, and, on the other, of putting to profit the ground itself for serving as a centering for the masonry.

The following was the modus operandi. In the first

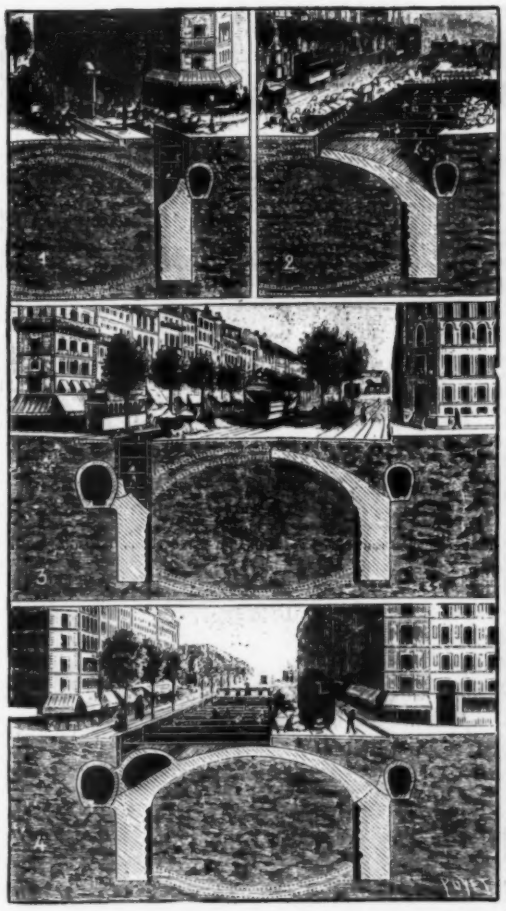


FIG. 1.—METHOD OF CONSTRUCTION OF THE SUBTERRANEAN PORTION OF THE PARIS-SCEAUX RAILWAY.

place, a lateral ditch was excavated, in which was established the masonry archbutment of the arch (Fig. 1, No. 1), and then the roadway was opened for half of its width, and the circulation of the vehicles, tram cars, and pedestrians was transferred to the other half (Fig. 1, No. 2). Upon the earth, worked into the form of an arch and covered with a smooth layer of cement, there was constructed half of the arch, which was connected with the archbutment (Fig. 1, No. 3). After the mortar of the masonry had set, the latter was covered and the traffic transferred to it, while the same work was effected on the other side (Fig. 1, No. 4). Finally, a tunnel filled with earth was obtained. It was only necessary to clear this and establish a floor, and the thing was finished.

The work necessitated a large amount of excavation. From June 15 to April 30, the date at which it was finished, the prolongation of the Sceaux line necessitated 209,564 days' work of excavators, absorbed 2,450,000 cu. ft. of sandstone, 13,120 super. ft. of rubble, and 8,750 cu. ft. of dressed stone, and occasioned a total expense of $940,000. It is well to add that large quantities of sand, lime and asphalt were used, and that about 950 tons of cast iron in various forms, as well as 130 tons of wrought iron, entered into the construction.

Ventilation of the Tunnel.—The ventilation of a tunnel of this kind is a fundamental operation. It has been thoroughly studied, moreover, in analogous examples in London and the United States. Our engineers, therefore, have not had much to seek for. Upon the development of the prolongation of the Sceaux line are constructed twenty-three rectangular kiosks designed to serve as draught chimneys. Moreover, the ventilation of the Luxembourg station, which is situated at the extremity of this great chimney, will be assured by means of a powerful ventilator installed in the cellar of the building.

Let us add that "big-lunged" locomotives, that give at will either little or no smoke, have been studied with a view to this service by the engineers of the Orleans Company.

Our electricians hope that in a near future, without excluding the free running of steam locomotives, electric traction by trolley will suppress smoke and steam. The electric locomotive, such as it is studied and projected, is surely the street railway engine par excellence.

Conclusion.—After an inspection of the subterranean railway, whose main features we have just described, it is impossible not to recognize with what precision and facility work of this kind can be executed in a large city. It is certainly preferable to construct an elevated railway when it can be done without prejudice to any material or artistic interest, but when we see this fine, wide, imposing aerated tunnel, we obtain a correct idea of the emptiness of the arguments of those who, opposed to the fundamental principle of a work of this kind, compare it in imagination to a vast sewer, a labyrinth, a place filled with horrible darkness, dampness and bad odors. The people, in quickly learning to make use of it, will become a good judge of it, and will soon demand an extension of it with that loud voice called public opinion.

The extension of the Sceaux line is all ready to be connected, near Cluny, with the metropolitan feeder of the Moulineaux Railway, which is in the course of construction and which also has reached the Esplanade des Invalides. It will connect therewith either upon the Seine wharves or upon the Boulevard Saint Germain. Then, crossing the Seine at a very acceptable gradient of three inches to the foot, or through a fine viaduct, it will go to join the tracks of the Station of the East, and, if occasion requires it, to connect at the right with that of Orleans. To prolong, as the project is, the Line of the North as far as to the Opera House and to the Halles, to extend the tracks of the Paris-Lyons-Mediterranean to the Boulevard de Strasbourg and those of the West also to Place de l'Opera, will not be very difficult. The metropolitan system of Paris will then have been established, and well established, without any one having scarcely been aware of it, so to speak.—La Nature.

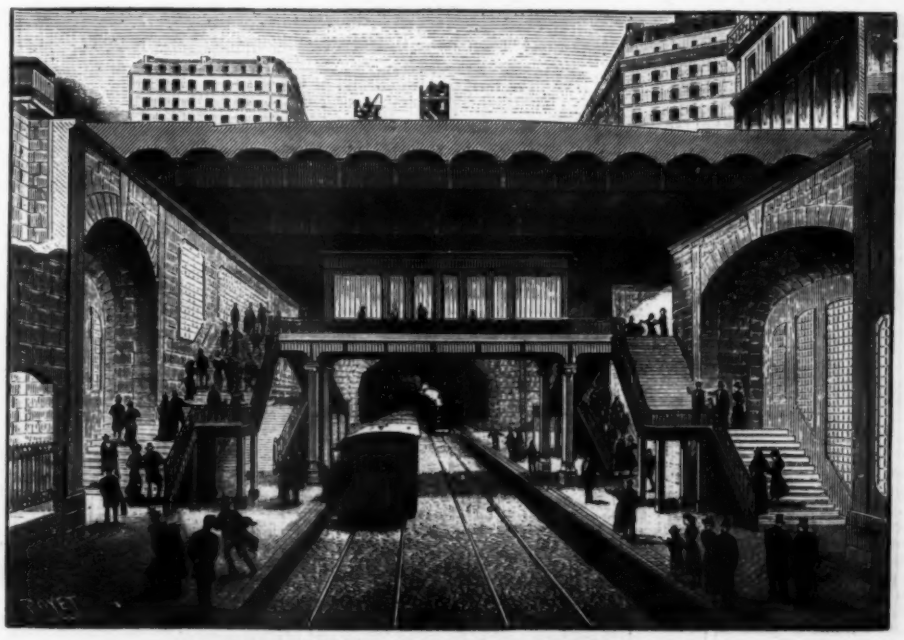


FIG. 2.—SUBTERRANEAN STATION AT MEDICIS PLACE.

THE LONG ISLAND WATER BASIN—BROOKLYN'S RESERVOIR.*

By A. N. BELL, A.M., M.D.

LONG ISLAND lies between Long Island Sound and the Atlantic Ocean north and south. Its length from the western end, washed by the East River and the Upper New York Bay, to Montauk Point, the eastern extremity, is 118¼ statute miles, and its greatest breadth 23 statute miles; but there are numer-

* Read at the Montreal meeting of the American Public Health Association, September, 1894. From the Journal of the American Public Health Association, January, 1895.

ous coves and small bays on both sides, which in several places leave less than half its greatest breadth between, insomuch that its average breadth is about 17 miles. A ridge of hills, beginning with the site of Fort Hamilton, at the Narrows, comprising Bay Ridge, Brooklyn Heights, and continuously other hills of various altitude, extends all the way along the north side to Montauk. This ridge is commonly called the "backbone" of the island. The hills are almost wholly covered with luxuriant vegetation of fruitful crops seasonably, as are also the valleys between. The highest of them, Hempstead Harbor Hill, at Roslyn, is 384 ft. above sea level. Two or three others are nearly as high, and the terminal one at Montauk is 194 ft. above the ocean. From the center of this ridge—varying in distance from 100 rods or so to 2 or 3 miles from the north shore—the surface descends southward, about 20 ft. to the mile, on the whole, but with some remarkable peculiarities. There are numerous narrow depressions, all taking their rise in the hills and extending southward, appearing very much like the dry beds of once flowing streams. With rare exceptions they are never flooded, because the porosity of the soil is such as to rapidly take up all the rainfall. These depressions become more and more shallow and broader as they descend, until they are finally lost within a mile or two of the south shore, in the general expanse of an almost level plain. Along the margins of these otherwise dry beds, and at many places in the sandy plain where all traces of them are lost, there are outbreaks of water—not springs—from the surcharged subsoil; and from these outbreaks rise many beautiful rills, some of which swell into brooks of considerable size, all running toward the ocean.

Equally remarkable is the number of basin-like dales scattered here and there all over the island. Many of them hold water all the year round, and some of them are pretty lakelets of a mile square or more. These "ponds" have no outlet except the overflow into the sandy soil by which they are bound, and over which they never flow. The depth of some of them extends to the full depth of the soil saturation, and these consequently are never empty. The water they contain, the same as that which breaks out in many places on the plain, is remarkable for its purity.

The structure of Long Island is bowlder and bowlder drift ground to gravel and sand by waves of the ocean during the period of coast subsidence. The sand and gravel rest upon an impervious stratum of hardpan or blue clay of variable depth; from within a few feet of the surface in some places—which places are on that account unhealthful—to more than 70 ft., in others, but with an average depth through the central part of the island of about 50 ft.; and throughout, even in the driest weather, this sand and gravel bed is loaded with pure water to within 25 ft. of the surface—a vast sand filtering reservoir, surpassing any which human ingenuity has ever contrived.

In the experimental and subsequent progress of the work for procuring the water supply of Garden City, fifteen to eighteen years ago, which fell under my personal observation, there was not a single particle of decayed or decaying organic matter of any kind discovered in the soil.

Garden City is situated at an elevation of 103 ft. above sea level, about midway between the shores of the Atlantic Ocean and Long Island Sound, 20 miles eastward from Brooklyn. In the process of sinking the well, the soil was found to be in layers, the beds having a dip southward. The depth of the subsoil at that place was 70 ft., but from experiments roundabout there was reason to suppose that in some places it was much greater. By boring through the gravels and sand at the depth of 70 ft., a dense stratum of hardpan was encountered. Six miles nearer the ocean the depth of sand and gravel was found to be 68 ft., resting upon a bed of blue clay. This underlying stratum of hardpan, or blue clay, beginning in the hills, extends not only quite to the south shore, but doubtless at some distance under the ocean beach beyond. Wells sunk sufficiently deep into this sand and gravel are of exceptional purity and inexhaustible.

The well at Garden City is 50 ft. in diameter; the surface of the water in it is commonly 25 ft. below the general level of the plain; but it is located in one of the river-bed-like depressions, 14 ft. below the general surface, so that the depth of the well to the surface of the water is only 11 ft. The depth of the water is 20 ft., and rises from the bottom. No water gets in through the sides of the well, because they were rendered thoroughly impervious in the construction. The enormous volume and pressure of the water from the sand and gravel bed into which this well is sunk will be appreciated from the fact that, while it was in process of construction, four wrecking pumps, discharging through pipes ten inches in diameter, were worked continuously day and night for a whole week, in order to keep the water sufficiently low to proceed with the wall. The water from this well is distributed by means of a Holly pump, adequate to discharge 3,000,000 gallons daily, and the supply is abundant.

At East Rockaway there is another well, similar to the one at Garden City, which by means of pump and pipe supplies Long Beach, 5 miles distant. This well is 38 feet in diameter, but only 20 feet deep. It is sunk from the level of the plain, only 10 feet above the tide level of the salt creek and marsh, but 20 rods distant. Yet the water, like that of the well at Garden City, is remarkable for its purity, and has never been known to possess the least brackishness. The average daily delivery is 200,000 gallons, but 500,000 gallons could be supplied if necessary without any danger of exhausting the supply. The depth of water in this well during eighteen years since it was sunk has never been less than 6 feet.

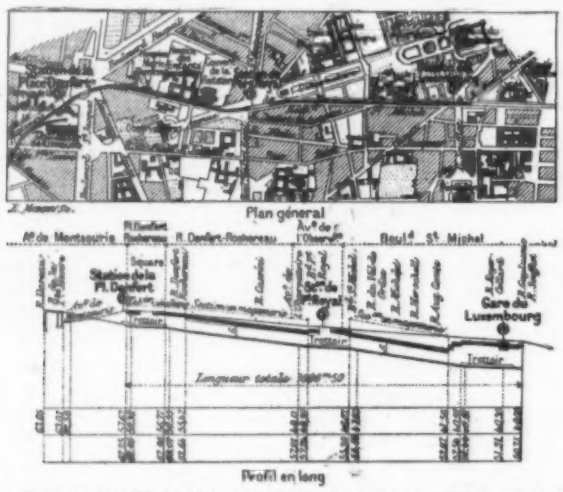


FIG. 3.—DIRECTION LINE OF THE PARIS-SCEAUX RAILWAY.

From the fact that the level of soil saturation, as discovered at Garden City, in the central portion of the island, is many feet above tidewater, there occurs a ceaseless flow of the subsoil water from the "backbone" toward the seashore, not in the form of a subterranean stream or river, but in entire mass filtering through sand and gravel; slow, indeed, but continuous, found by actual observation over a wide area to move at the rate of from 8 to 12 feet daily.

The annual average rainfall over Long Island is 43 inches. It has been estimated that three-fourths of this sinks into the soil. The surface waste is very small; indeed, there is scarcely any except in winter, when and where the ground is frozen. It is certain, therefore, that the entire volume of the rainfall, excepting this small waste in the winter time and that which is lifted by evaporation or absorbed by vegetation, is carried by the soil.

Forty-three inches of rainfall is more than 3½ cubic feet upon a square foot of surface. For convenience of calculation, let us assume that 3 feet sink into the soil. This would give more than 83,000,000 of cubic feet to the square mile, or 2,500,000 tons. A freight car will carry 10 tons. Two hundred and fifty thousand cars, therefore, would be required to convey the rainfall upon one square mile in a year.

The whole surface area computed is about 2,000 square miles. One-half of this area at least would fall within the most favorable conditions described; hence it is quite safe to estimate the size of this reservoir to be 1,000 square miles, with an average depth of 50 ft. This is Brooklyn's reservoir—the primary source of her water supply. The "ponds" are intermediary, mere convenient holds that have been utilized.

While the waste of streams is enormous, it is, nevertheless, from a knowledge of the conditions of the soil and the examples cited of the wells sunk into it, easy to appreciate the inexhaustible adequacy of the Long Island water basin to supply water sufficient to meet the demands of Brooklyn for all time, and the folly of those who would, in the face of such knowledge, seek it elsewhere.

INDUCED DRAUGHT.*

By Mr. W. A. MARTIN.

INDUCED or exhaust draught has been adopted in various forms for many years, and has been employed especially on locomotives from the commencement of railways up to the present. It is the best known means of promoting rapid steam generation with safety.

The locomotive type of boilers has been largely adopted for marine purposes, but the system of working them has been reversed with very unfavorable results. The author, having made a large number of experiments in steam generation with all classes of boilers, is enabled to place before the meeting some particulars that may be interesting, both on forcing and inducing draught.

Although it has been sometimes maintained that so long as you create a difference in pressure beween the air in the chimney and that in the stokehold, it matters not whether you exhaust from, or below to, the fire; yet it will be seen, upon closer examination, that the characteristics of forcing and inducing are widely different. The forcing system is advantageously used for blasting down ores, and for iron foundry purposes, where the metal can fall below the blast as soon as melted; but it is an unsuitable process for puddling, reverberatory and reheating furnaces, such as are used in iron and armor plate making, where volume and steady heat are required. For these purposes exhaust or induced draught is used.

The marine boiler exposes a large amount of surface to be acted upon, and it is of primary importance that the heat should be evenly distributed over it, and not concentrated on particular parts. To effect this the draught must have perfect control over the gases generated in the furnaces, as on the proper application of the draught the whole working of the furnaces depends. It is a tendency of the forced draught system, as used in the navy, to concentrate and localize the heat. The initial effect of the draught is under the body of the fuel, and the gases generated are driven on without any controlling influence, whereas, with induced or exhaust draught, the initial effect is on the top of the fuel, and the gases evolved are under control of the draught until they are passed through the funnel. The effect of the draught is constant, the gases become perfectly developed and consumed before leaving the tubes; hence a lower temperature in the uptake and funnel, and comparative absence of smoke with induced or exhaust draught.

The author is indebted to the Admiralty for permitting an extensive series of experiments upon his system to be carried out on board H. M. S. Gossamer, at Chatham. This ship had been fitted and worked with forced draught prior to these experiments. There are two boiler rooms identically similar, and two boilers in each, of the locomotive type. The forward boilers were selected for the application of the induced draught system, which was fitted in the uptake forward, leaving the stokehold in its original condition, with the air locks and other forced draught fittings unnecessary for induced draught. The air locks and hatches, however, were left open during the trials, and in this respect only was there any difference in the working of the two systems.

The following table gives a summary of the trials that were carried out. It will be noticed that the power produced by the boilers with the induced draught system was far in excess of that developed under forced draught; also, that in point of economy induced draught was greatly superior. The table is by no means exhaustive, as there are other points not noted, such as the greatly lessened temperature both in stokehold and funnel, the immunity from dust, and the freedom of ingress and egress in the stokehold:

EXPERIMENTS AT CHATHAM WITH BOILERS ON BOARD H. M. S. GOSSAMER.

Date of Trials.	Description of Trials.	Hours.	Indicated Horse-Power. Intended.	Indicated Horse-Power. Actual.	Revolution of Fans. Starboard.	Revolution of Fans. Port.	Indicated Horse-Power per Foot of Grate.	Grate Surface.	Pounds of Coal per Indicated Horse-Power.	Pounds of Coal per Square Foot of Grate.
1893.										
March 6 and 7	Induced draught	30	1250	1228.11	339	353	16.3	79	1.92	31.3
May 1 to 5	Forced "	93	750	710.69	219	214	8.99	79	2.22	20.57
1894.										
February 7, 8, and 9	" "	48	750	772.64	310	304	9.77	79	1.87	18.29
" 14, 15, and 16	Induced "	48	750	825.81	258	268	10.45	79	1.68	17.56
" 22 and 23	" "	24	1000	1004.04	410	426	12.709	79	1.60	20.36
" 27	Forced "	6	1000		Trial abandoned on account of priming					

Grate surface, 143·22 sq. ft.; tube surface, 5,772 sq. ft.; number of tubes, 1,728; length, 7 ft. 1⅛ in.; diameter, 1¼ in.

It may be mentioned that the above trials were arranged by the Admiralty as a more crucial test, and to institute a comparison with experiments made some time previously on a boiler of the same kind which had been taken out of H. M. S. Polyphemus. The following is a record of the results of the 96 hours' run which took place with each system on that occasion:

* Paper read before the Institution of Naval Architects.

EXPERIMENTS AT PORTSMOUTH DOCKYARD WITH BOILER EX H. M. S. POLYPHEMUS.

Date of Trial.	Description of Trial.	Duration of Trial.	Average Pressure of Steam.	Temperature. Fred.	Temperature. Atmosphere.	Revolutions of Fan.	Total Coals Consumed in Pounds.	Total Water Evaporated in Pounds.	Pounds of Water Evaporated per Pound of Coal. At Actual Temperature.	Pounds of Water Evaporated per Pound of Coal. At 212 Deg.	Pounds of Coal Consumed per Square Foot of Grate per Hour.	Water Evaporated per Square Foot of Grate per Hour. At Actual Temperature.	Water Evaporated per Square Foot of Grate per Hour. At 212 Deg.	Indicated Horse-Power Approximate.	Pounds of Ashes.	Pounds of Clinkers.
1890.		hours														
Aug. 5 to 9	Induced Draught	96	74.2	62	69.9	485	80,600	777,044	9.64	11.13	46.4	388.6	450.57	428	3088	1202
Oct. 29 to Nov. 1	Forced Draught	96	77.3	51	49.8	372	94,100	769,328	8.03	9.3	47.3	381	444	326	3504	1897

Length of tubes between tube plates, 8 ft. 6 in.; number of tubes, 258; diameter, 1¾ in. outside; area of fire grates, 20·77 sq. ft.; indicated horse power of fan engine, 1·78 per cent. of power produced.

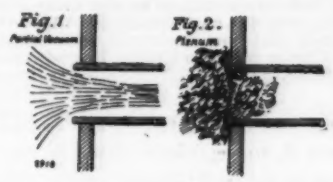
In this case both series of experiments were conducted on the same boiler, the induced draught installation being dismantled after trial and substituted by the forced draught system.

It will be seen that the trials on board the Gossamer confirm and verify those which were made in the Polyphemus boiler. In the case of the Gossamer especially, it was found that with forced draught the boilers could not be worked at anything approaching the rates attained by induced draught without priming taking place, for which reason the final trial of forced draught had to be abandoned after six hours' run.

It has been observed that the boilers of the Gossamer had been worked under forced draught previous to the experiments here recorded. It should also be added that they had been damaged and weakened to a considerable extent. It was, therefore, necessary in both the induced draught and the forced draught trials to use more care and caution than would otherwise have been necessary, but the author's experience is that very high rates of steaming may be practiced with induced draught with perfect safety, as the tube ends and other surfaces are protected by the partial vacuum which takes place, and within a certain limit it may be said the greater the speed of draught, the greater the immunity from damage to the boiler. The author has driven an ordinary marine boiler to the utmost limit that the coals would endure without producing the slightest injury to the tubes or any part of the boiler. The heat is drawn off rapidly and distributed over the whole surface of the tubes, observations taken proving that there is very little difference in temperature either at the front or back part of the tubes. This uniformity of temperature is an important factor in generating dry steam. Another important point in favor of induced draught is the saving in weight in comparison with forced draught. The ironwork involved by the latter for casing and air locks in a first-class battle ship is about 19 tons. This is dispensed with by the induced draught system. The economy of fuel effected also tells in connection with weight. For instance, reverting to the Polyphemus trials, it is therein demonstrated that with the coals burnt in the 96 hours under forced draught, the boiler could have steamed 112½ hours, at the same time exerting an excess of 31 horse power.

It will be seen that by the action of induced or exhaust draught the heat is drawn off without being allowed to expend its force locally. It should also be observed that the principle of reduced draught renders it quite independent of the length of funnel. In fact, the funnel may be dispensed with altogether, so that in the case of a war vessel, if the funnel were shot away in action, it would not in any way affect the facility of steaming. The appended sketches convey an approximate idea of the flow of the gases as they enter the tubes under a partial vacuum in the one case and with forced draught in the other.

It is remarkable that while the forced-air system results in diminishing economy as the blast is raised, and there is a maximum pressure beyond which it is difficult to work at all, the induced system, on the contrary, gives an increased draught with no limit



but the convenience of obtaining high speed of fan. The gases being drawn through the tubes instead of being forced, are more perfectly consumed, and there is no lodgment of ashes in the tubes. So regular is the process of combustion that the quantity of coal consumed does not increase in anything like the same ratio with an augmented rate of working.

The action of the gases under the influence of induced draught is best illustrated by a model which the author will show.

MACHINERY OF H. M. S. MAGNIFICENT.

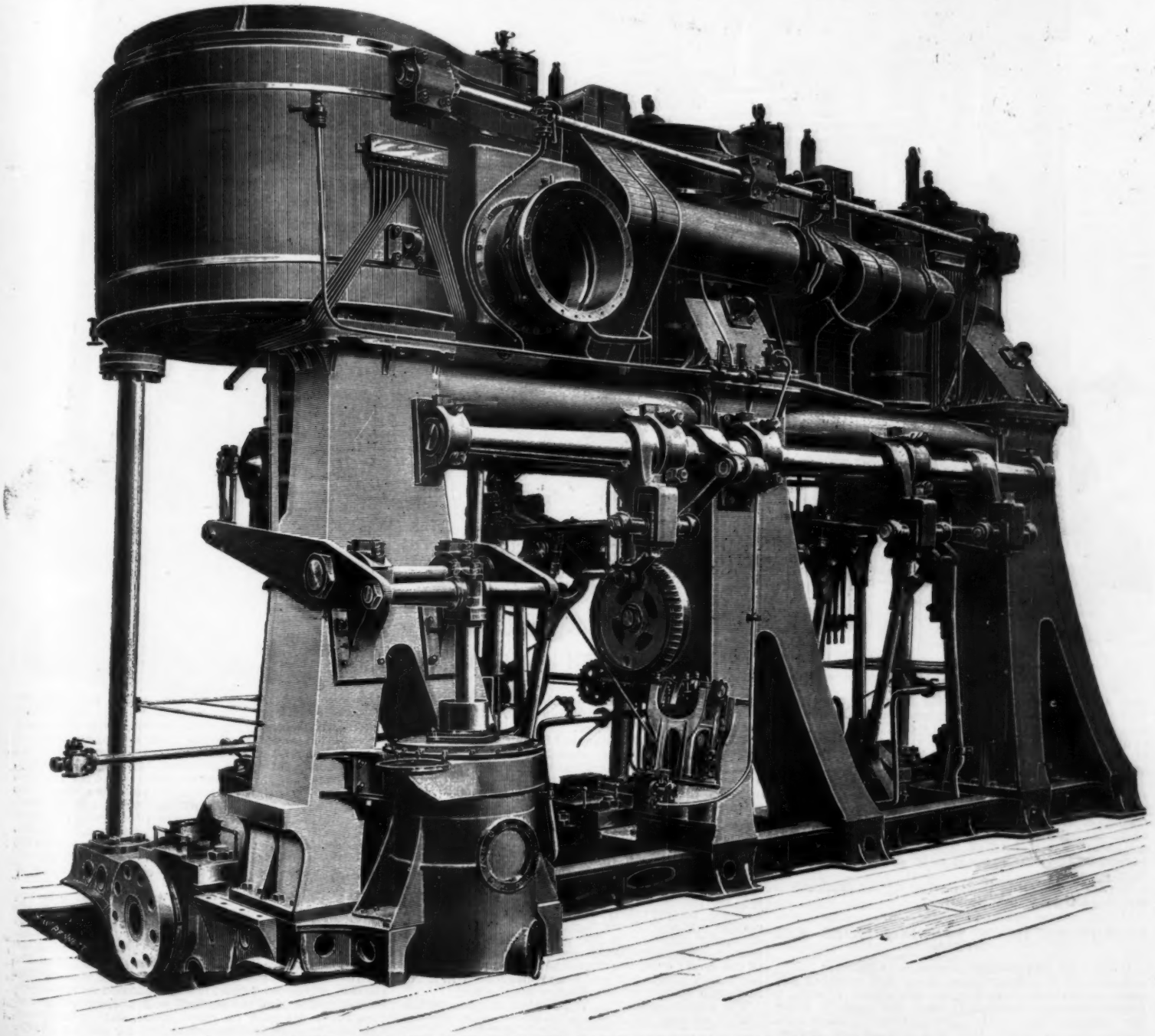
WE give this week a front and back view, and an end view, of one of the twin sets of triple expansion engines constructed by Messrs. John Penn & Sons, of Greenwich, for the new line-of-battle ship Magnificent, floated out in December last at Chatham dockyard, and now being completed at that establishment. As to the ship, it may here be stated that she belongs to the largest class yet constructed, the displacement being 14,900 tons, of which 10,180 tons is due to the weight of the hull. The length is 390 ft., the beam 75 ft., and the mean load draught 27 ft. 6 in. As regards the general features, already described, it is interesting to note that such experienced critics as Lord Brassey and Lord Charles Beresford have, at the meetings of the Institution of Naval Architects, expressed their approval in terms most complimentary to Sir William White, the chief constructor. The vessel will carry four 12 in. breech-loading guns, twelve 6 in., and thirty smaller quick firers.

The machinery, which has been designed by Mr. J. P. Hall, the managing director of the firm, is to develop 12,000 indicated horse power with induced draught and 10,000 indicated horse power with natural draught, the speeds at these powers being 17¼ and 16½ knots respectively. The engines are somewhat similar to those for the first-class cruiser Crescent, drawings of which were reproduced in Engineering, vol. lv., p. 785, and in view of the great interest attached to weights and to the fact that the framing is so distinctly shown in our engravings, it may be interesting to state that the bedplate, which is of cast steel and strongly secured to bearers built into the ship, weighs 36 tons, and the standards and guides 46 tons; the total being 82 tons. The back columns are of cast iron, while forged steel is used in the front columns, the motion bars being attached to the back columns.

The engines have cylinders 40 in., 59 in., and 88 in. in diameter respectively, all with 51 in. stroke. The high pressure cylinders are placed forward, and are fitted with piston valves, while the intermediate and low pressure slide valves are of the double flat valve type. The reversing gear is of the ordinary link motion type, with solid bar links and adjustable working parts. Both steam and hand reversing gear are fitted. The cylinder covers, pistons, and steam chest doors are of cast steel. The piston and connecting rods are of Siemens-Martin steel, the piston rods being fitted with combination metallic packing. The crank shafts are hollow, of forged steel, in three separate pieces, the cranks being set at 120° apart.

The propeller shafting is hollow, of forged steel, 14¾ in. in diameter inboard, and 16 in. diameter outside the ship. The propellers are of gun metal, four bladed, and are 17 ft. in diameter by 19 ft. 9 in. pitch.

The surface condensers are made entirely of brass, the total cooling surface being 13,500 square feet. The circulating water is supplied by four 10 in. centrifugal pumps, made by Messrs. Penn. The air pumps are entirely of brass, and are worked from the low pressure piston rod crossheads; they deliver into a feed tank which overflows into the ship's fresh water



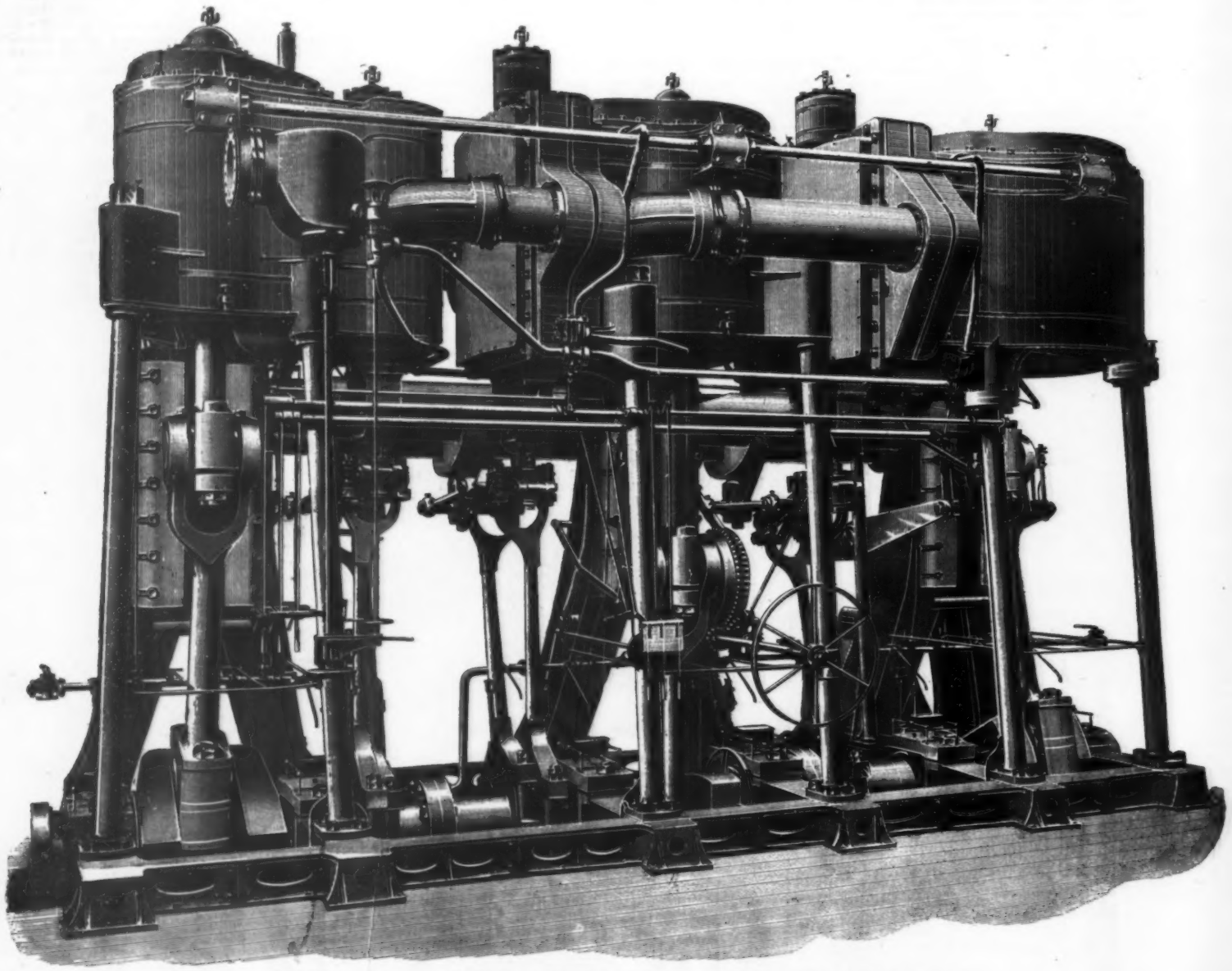
TRIPLE EXPANSION ENGINES OF H M. S. MAGNIFICENT.

reserve tanks. One of Weir's evaporators and Kirkaldy's distillers are fitted to each engine room. They will make together 180 gallons of fresh water per hour; while the evaporators can supply 400 gallons per hour to the auxiliary condensers. The last named are two in number, and are made entirely of brass, and fitted to condense the exhaust steam from all the auxiliary engines on board. There is a Weir's feed pump in each engine room and a Weir's auxiliary feed pump in each boiler room. Electric light machinery is supplied and fitted on board. Air-compressing machinery is fitted in duplicate at each end of the vessel. Powerful boat-hoisting engines will be supplied and fitted on the upper deck.

As to the boilers, the feature is the fitting of Martin's system of induced draught into this battleship. The principle of the arrangement is well known, fans being placed in the uptake, where they tend to create a partial vacuum. As this is the first large ship on which the system is fitted—it has been tried with satisfactory results on the torpedo gunboat Gossamer—the results of the speed trials will be watched with great interest. We shall then return to the subject, but meantime may say the boilers are eight in number, of the marine return tube type, 16 ft. 1 in. in mean diameter and 9 ft. 3 in. long, each containing four of Fox's corrugated furnaces 3 ft. 8 in. in mean diameter. They are of Siemens-Martin steel throughout, and are designed for a working pressure of 155 lb. per square inch and a proof pressure of 245 lb. per square inch. The heating surface is 25,248 square feet and the grate area 855 square feet. The main steam pipes are 14 in. in diameter, and made of steel; while all copper pipes of 6 in. and over are wound with copper wire for greater security.

Both sets of engines are completely fitted on board, and are now preparing for testing, and all the boilers with their uptakes are in place and the decks and casings closed up. Satisfactory progress is also being made with the armored parts of the ship, and great hopes are entertained of the vessel being so far advanced by the early summer as to enable her trials to be then made.

We are indebted to Engineering for our illustrations and the foregoing particulars.



TRIPLE EXPANSION ENGINES OF H. M. S. MAGNIFICENT.

IMPROVEMENTS IN TANNING SKINS AND HIDES.

BAKE AND LEVERETT'S process is as follows:

A current of hydrogen gas, or of any suitable gaseous compound of hydrogen, containing arsenic, is caused to pass at intervals through the liquor in which the hides are suspended. The hydrogen is made from commercial sulphuric acid and zinc or iron, or from iron and steam. It is stated that "in these cases it will be found that arsenic will be present with the hydrogen gas in quantities sufficient for the purpose."

The hydrogen is stored in a gas holder, whence it passes into a smaller gas holder from which it is forced through a pipe leading to the bottom of the tan pit and delivering the gas through a number of holes. The gas which has bubbled through the liquor is conveyed back into the large gas holder by a pipe opening out of the cover of the pit. By regulating the pressure in the small gas holder the flow of gas may be made intermittent. Larger pits than those customary are used, and the handling of the hides is dispensed with. The duration of the tanning is said to be much abbreviated, and the quality of the leather to be equal to that of the best that is tanned by the more lengthy processes.

THE SAND BLAST PROCESSES.*

By JOHN J. HOLTZAPFFEL, Assoc. M. Inst. C.E.

A PAPER on the sand blast was read in this room by Mr. William E. Newton, in February, 1875. The invention was then in comparative infancy as regards apparatus and its practical applications in manufactures and the arts. Notwithstanding its continual developments in both particulars, the sand blast is still not popularly known; it is considered that something more may now be said on the subject, and this paper will describe some of the apparatus used and its services, after which it is proposed to show you a few examples of actual practice.

The sand blast was invented by Mr. Benjamin Chew Tilghman in 1870, and, stated shortly, consists of a stream of sand or other abrasive powder, usually dry, but sometimes mixed with water, projected with more or less force and velocity to strike and pulverize the surfaces of glass, stone, metal and other materials upon which it is directed.

It has been frequently pointed out that, in this invention, Mr. Tilghman has really borrowed or adopted from nature herself, inasmuch as he has intensified and put to use a natural force, of which the effects are always apparent under favoring conditions; that is to say, wherever we find large deposits of loose sand exposed to prevalent winds, by which the sand is caught up and blown against any hard substance, such, for example, as the glass in a window, which soon becomes depolished and obscured by the contact of the sand; or stone, the surface of which, with time, is sensibly roughened and sometimes scored in a manner quite distinct from ordinary weathering.

The abrasives used in the process include ordinary inland silicious sand, sharp builders' sand, powdered glass, emery, from fine to coarse, chilled iron-sand and steel shot; and the streams of these powders are forcibly projected through variously formed nozzles by means of steam, by currents induced by exhaust air, by blasts of air, and latterly, and more conveniently, by compressed air. Sand, from its plenteousness and general suitability, is mostly employed; that used in London comes from Reigate, and, when freed of pebbles and impurities, is again sifted into several sizes for different classes of work.

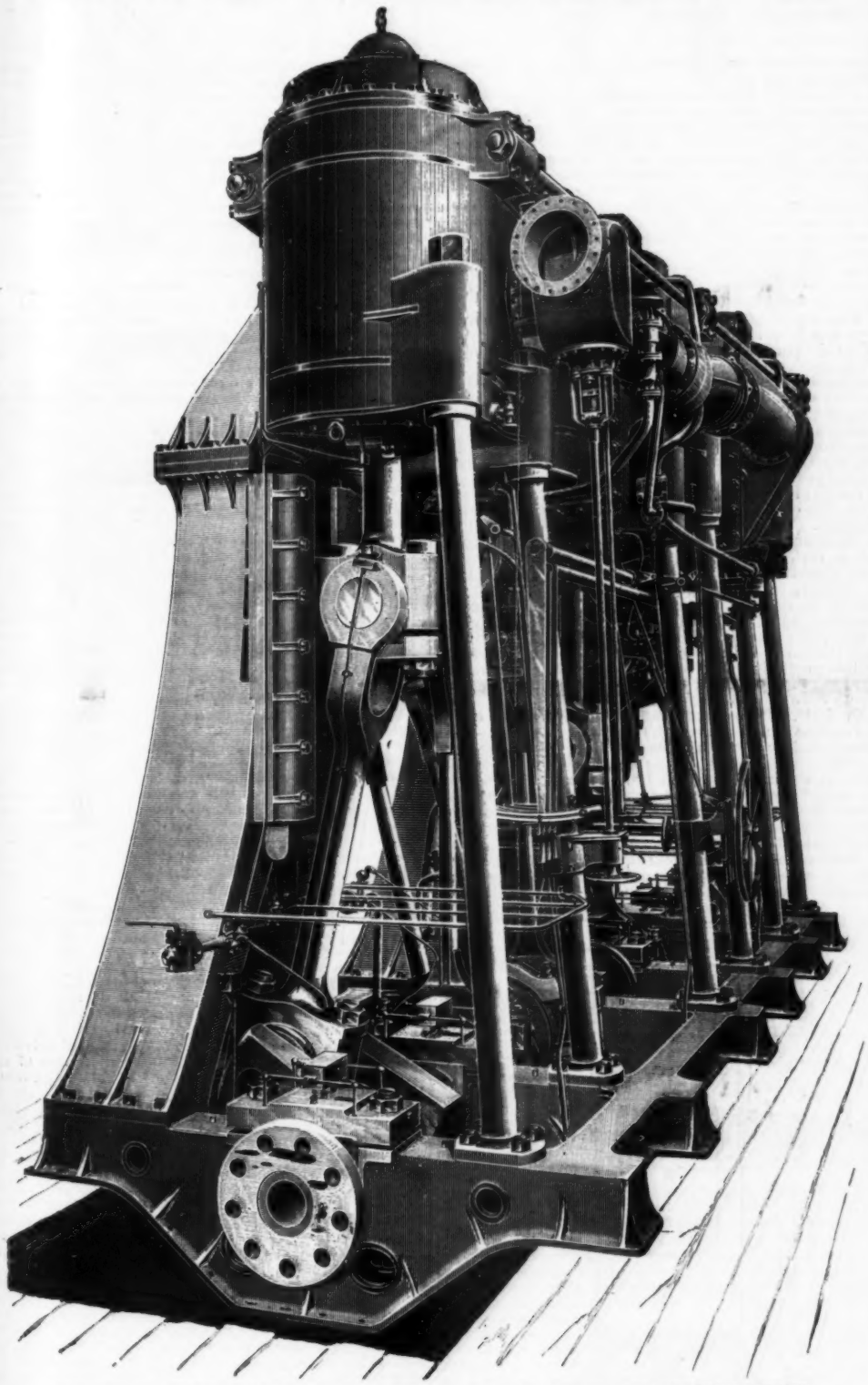
Grains of sand have numerous angles, and the action of these grains—as also that of the other abrasives mentioned—upon the surfaces of glass, stone or metal, is due to the circumstance that every individual grain in the incessant infinite number in the stream urged violently forward has all its energy instantly arrested, transferred and concentrated upon its point of impact, where it produces a minute pit or depression; and, as every grain in the shower acts alike, the abrasion resulting from the whole is perfectly uniform in depth and texture or roughness.

The action, moreover, is extremely rapid; as you will see later, a momentary application depolishes glass over any space that can be covered by one stroke of the sand shower, instantly changing the previously bright surface to obscured or that known as ground glass. A little longer exposure cuts more deeply, and, with further time, apertures are readily pierced through sheet and plate glass.

Stone, marble, slate and granite are just as amenable to its action. Iron, steel and other metals have their surfaces easily reduced, and smoothly or coarsely granulated, according to the force and abrasive power used; but all these materials, being less brittle than glass, take a rather longer time. Speaking generally, it appears that the harder or more dense the material acted upon, and the higher the velocity given to the sand, the more rapid the cutting action; and the finer the abrasion, and the lower the pressure of the air or steam, the finer the granulation produced. It is also remarkable, that it is by no means necessary that the abrasive be harder than the material to which it is applied, thus, hardened steel and corundum are readily pierced with sand.

This granulating, scaling, incising and piercing, however, is but one-half of the process, for, if the work be partly covered and protected by some slightly yielding but tough substance, adhesive or in the form of a metal template lying closely upon it, this interposed substance instantly diffuses the shock of the particles and neutralizes their abrasive power. The action of the sand blast is thus confined to the unprotected portions of the surface, and these overlays and templates are used on glass, stone, slate, pottery and metal for surface ornamentation, for deeper intaglio and perforations.

* A paper recently read before the Society of Arts, London. From the Journal of the Society.



TRIPLE EXPANSION ENGINES OF H. M. S. MAGNIFICENT.

All results from the sand blast arise from the cumulative action of the immense number of grains of the abrasive powder striking the surface; but the impact of every individual grain does but an infinitesimal portion of the work; hence, as unusual as important, the very rapid erosion is really most gentle in character, with total absence of risk of damage to the material, however fragile, as, for example, the splaying or chipping of edges met with in carving stone by hand.

The sand blast is in constant use for obscuring or producing a uniform granulation, known as ground glass, on sheet glass, lamp globes, the bubbles for incandescent lights and the like; for the decoration of sheet or objects in glass with ornamental designs, in which the pattern or the field may be left bright and transparent, of which there are numerous varieties, one being on glass of two or more thicknesses of different colors, to leave the design of one color on a field of another; for the decoration of glass table ware and the labeling of measures, chemists' and other bottles. Several examples lie on the table.

In metal, for the removal of the hard scale, so destructive to cutting tools, from castings and forgings. The removal of the scale from sheet iron and steel prior to enameling, galvanizing, nickeling, tinning, etc.; the cleaning of tubes and brazed joints, largely used in bicycle work. Sharpening the teeth of files. For granulating or frosting electro-plate, gilding metal, gold and silver smiths' work, and jewelry; and the reduction to clean metal surfaces of larger works, ranging from the steel forgings of safes to armor plates. On stone, slate, and granite, for incised carving and inscriptions in intaglio or relief; for cleaning off the grime from stone, granite, and brick buildings, and in contrast to this last, for the most delicate drawing for lithography.

Among other purposes, it is employed for removing fur and deposits in tubes and tanks; for cleaning off accumulations of paint and dirt within iron ships; for roughing the surfaces of metal rollers; for decorating coat and other buttons; for granulating glass to give it a key for ornamental painting by hand; for piercing the apertures in glass ventilators; for marking cakes of cement and glue; for marking pottery, and in the manufacture of ornamental tiles; for smooth-facing bricks to receive white glass or enamel; for refacing grindstones, emery, and corundum wheels; for granulating celluloid films for photography; on wood, to bring out the grain in relief, and, latterly, for blocks for printing.

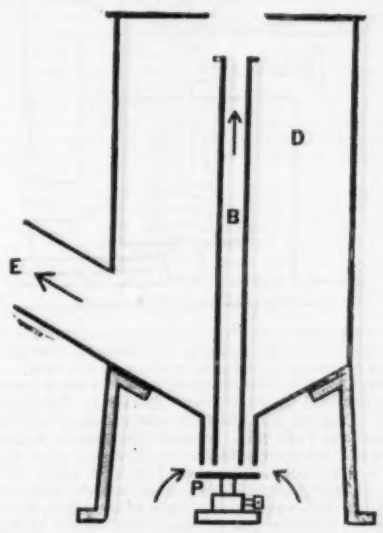
A list of its users cannot be attempted, but includes the name of Sir W. Armstrong, Charles Cammel, Chatwood, Sir John Brown, Jessop, Sanderson, Turton, Vickers, many English and foreign railway companies, Areulus, Chance, Dixon, Hartley, Hole, Pilkington, and others.

The protecting overlays used in glass decoration are made of a quick-drying, viscid mixture of glue, dextrine, glycerine, and any powder coloring matter to give body; they readily wash off in warm water after use. Sometimes they are painted on by hand; for many repetitions, they are printed from wood block patterns on paper, then laid on the glass, and the composition transferred by rubbing, or it is applied through thick tinfoil stencil plates with a palette knife. For figures and original designs, the glass is entirely covered with a sheet of paper dipped in the mixture, through which, when dry, the design is cut out with a pointed knife; sometimes numerous morsels of the prepared paper are separately attached to the glass.

In all stencil plates there are many isolated solid portions, as, for example, the center of a letter, O, which have to be retained in their positions by bars or ties, which cross or interfere with the continuity of the apertures desired around them. For the best works, required in quantities, this is overcome by using two or more tinfoil stencil plates, the first giving the design and the second pierced only with holes corresponding to these ties, to blot them out. On the table there are some such stencil plates, with impressions showing their separate and combined results, and glass with the completed overlay from them.

As to apparatus. An early exhaust air machine (Fig. 1) has a closed iron drum, D, about 30 inches diameter, with an open central pipe, B, and below the latter a vertically adjustable plate, P. The head of the drum has an aperture about 4 inches diameter, closed by the work, overlay downward, lying upon it, the exhaust being at E. The sand from a closed box falls down the pipe, E, to the bottom of the drum, on to the plate, P; thence impelled or sucked up the blast pipe, B, by the external air rushing in above the plate, P, it strikes the work, which is moved about by the operator, who looks through the glass to watch the progress of its

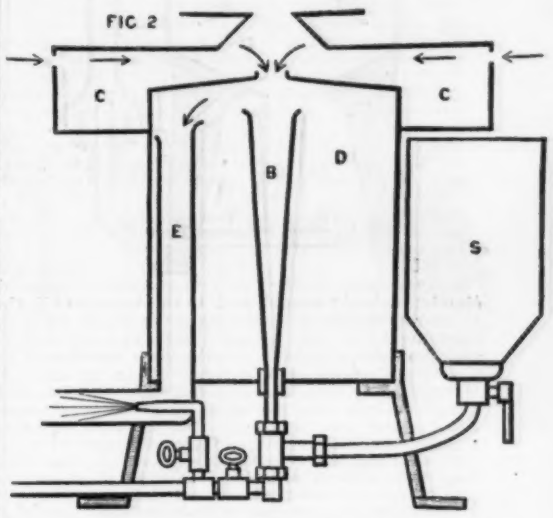
FIG 1



frosting. Most of the sand falls back to the bottom of the drum, some, with the dust pulverized from the glass, is carried along the exhaust back to the sand box. The air pressure does not exceed one pound to the square inch, the frosting is almost instantaneous, and the hand may be held in the blast without inconvenience. Several machines are connected to one exhaust running round the workshop; they are used for small work, but are capable for sheet as large as can be conveniently moved about by two men.

Steam in place of exhaust air has the objection that its moisture damps, and causes the sand to clog about the edges of the overlays. This is partially obviated in one of Mr. Mathewson's earlier machines (Fig. 2). The drum and blast pipe are virtually as before, but D is surmounted by a circular casing, above which the work is laid; the periphery of this casing, C, is pierced with numerous holes, and the drum contains a large exhaust pipe, E, worked by a steam jet from the same pipe that supplies the steam blast. The latter, at about 20 lb. pressure, carries the sand, falling into it through a pipe from S, up the blast tube, B; and the dry external air, rushing in all around C, crosses

FIG 2

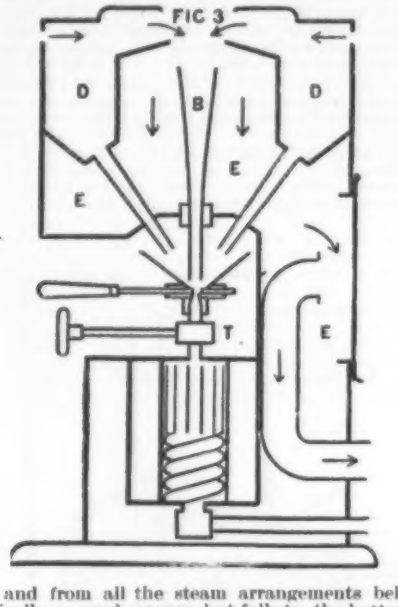


the sand blast just before that strikes the work, to find its way down the exhaust, E, carrying a great part of the moisture with it.

Drying the steam is nearly perfect in a later machine from the same hand, indicated by Fig. 3; and is effected at two operations, the first presenting an analogy to the ordinary centrifugal desiccator. The steam passes upward first through a helical passage, a tubular plate screw, and then still rapidly whirling, through a plain cylinder, a continuation of the outer wall of the screw, pierced with numerous vertical slits through which the more decided moisture is ejected; all this is at the base of the machine in a box from which the condensed water escapes below. The partially dried steam then rushes upward by a straight pipe, the contracted end of which is just separated from the lower end of the blast pipe, B, within a funnel, into which the dry sand drops through tubes from the supply in the drum, D, and is used over and over again. The volumes of steam and sand are regulated by throttle and plate valves, the handles close together.

The head of the drum is pierced around with holes, like the casing in Fig. 2, and with its large exhaust chamber, E E E, operated by a pipe below, dries the steam a second time as it issues with the sand from the mouth of B. The chamber, E E, is entirely cut off from the annular portion of D, containing the dry

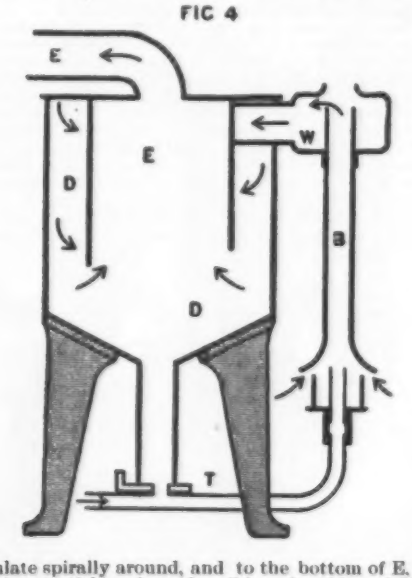
FIG 3



sand, and from all the steam arrangements below; practically no sand escapes, but falls to the bottom of E, and is removed through a door at the side.

An exhaust air machine (Fig. 4), in like manner, is now preferred to that first described. The drum has a large exhaust chamber, E, open below and worked from above; D also carries the sand, which falls through a pipe, regulated by a valve, into the open end of the tube, T, one and a half inch diameter, which, bent upward, terminates within the open bell mouth of the lower end of the blast pipe, B, 2 inches diameter, outside the drum. The upper end of B is contained within a box, called the working chamber, provided with an aperture above, upon which the glass is placed. The sand carried up T, by the current induced by the exhaust, as it issues is caught by the stronger current of external air entering all around the open bell mouth of B, and thus accelerated travels upward and strikes the work. The exhaust then carries the spent air and sand from the working chamber, W, to the annular space between E and D; here both

FIG 4



circulate spirally around, and to the bottom of E, the heavier particles of sand striking the sides of D by centrifugal force, and falling to the bottom, the lighter and the dust pulverized from the glass, traveling with the air up within E, and away along the exhaust. Virtually free from the escape of sand, the machine almost entirely sifts the dust from the sand, which latter is used again and again. Large sheets of glazing glass, covered with their overlays, are frosted as to the ground or pattern, while gently traveling upon two long, wide, horizontal surfaces or tables placed end to end with a small interval between them; by means of a narrow, uniform stream of fine dry sand extending the entire length of this interval, impelled upward by exhaust air at about 1 lb. pressure, to strike the constantly moving glass. This very long, narrow jet issues from between two iron plates, a quarter of an inch distant at their upper edges, or mouth, but more separated and also open below, beneath which the sand, supplied from a long, horizontal, hollow plate screw of 2 inch pitch, falls from a slit in its case to a trough, and is caught and carried up by the exhaust air. After striking the glass, the sand falls back into a chamber separated from that below but connected with the exhaust, by which latter it is carried through large pipes to a drum or sand chamber above. In this, after pressing through four double cylinders, placed radially in the head of the drum—of the same character and for the same sifting of the sand as the one described in Fig. 4—the sand cleansed from the dust falls to the bottom to pass to the screw for reuse. Two spindles carrying a number of small India rubber tired wheels, one to either side of the interval between the tables, the one driving the other by gearing, hold down and traverse the glass. Machines with tables

LONDON COUNTY COUNCIL—PUBLIC CONTROL DEPARTMENT—RETURN ON SAND BLAST MACHINES IN USE AT THE FOUR PRINCIPAL WEIGHTS AND MEASURES OFFICES.

Office.	Machine and motive power.	Men employed in working.	Average number of glasses marked per hour.	Average cost per 1,000 glasses. Labor.	Water or gas.	Total.
				s. d.	s. d.	s. d.
WESTERN, Edgware Road.	Tilghman's. Hand power. (Mathewson's patent)	2	650	1 6	.....	1 6
NORTH CENTRAL, Rosebery Avenue.	Tilghman's. Hydraulic power, worked from New River Company's high pressure main. (Mathewson's patent)	1	500	1 0	1 1½	2 1½
EASTERN, Bethnal Green.	Tilghman's. Hand power. (Mathewson's patent)	2	650	1 6	.....	1 6
SOUTH CENTRAL, Newington.	Tilghman's. Compressed air, worked by half horse power gas engine. (Mathewson's patent)	1	1,200	0 5	0 1	0 6

5 feet wide will obscure sheet glass at the rate of about 300 square feet per hour.

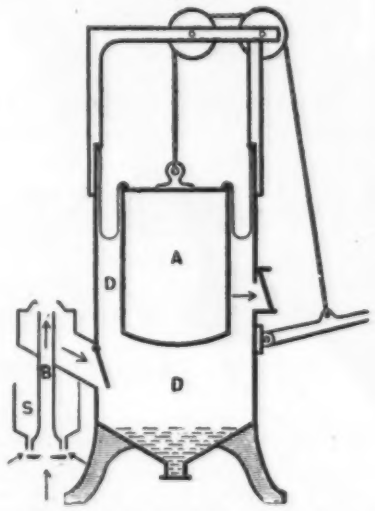
A beautiful translucent variety, known as chip or crystalline glazing glass, covered with gray filaments and fern and feathery markings on an ice-like ground—specimens of which are on the table—is also remarkable for the peculiarities of its manufacture. The surface, first uniformly frosted with the sand blast, is then covered with a coat of strong glue, and when this has set, the sheets are placed in horizontal racks in a room heated to 160°. In the course of ten or twelve hours, the hardening glue audibly cracks and springs off in patches, bringing away thin flakes of the glass with it. The fern-like markings are irregular portions of the original sand-blasted surface which remain on these flat conchoidal fractures.

This simple process was discovered by an accident, and put to use by Mr. Corsan. Beyond the curious fact that glue, under such conditions, will tear flakes from glass, the explanation appears to be that the hardening glue gradually blisters, and these blisters as they detach, tear off more of the glass by their margins than toward their central portions, which latter leave the fern-like markings. By the employment of the ordinary overlays prior to frosting and gluing, the crystalline effect is sharply localized and confined to any portion of a design.

Lamp globes and spherical objects are plain or pattern frosted all over their superficies in an ingenious manner. The drum of the machine—about as high as its diameter—has a hinged cover, and moves round on a central vertical pivot. Diametrically within the drum is a spindle, or rather the two ends of a spindle, its central portion removed and replaced by corresponding rods, with spring means of holding, which carry the glass globes. The globe when in its place is exactly in the center of the drum, and the tube of the sand blast presented horizontally, points precisely to the center of the globe. During the frosting the spindle is continuously turned, and the drum itself moved round on its pivot through about a half circle, both automatically; the central line of the spreading sand shower—its most active part—thus always points to the axis of the globe, which secures absolute uniformity in the texture of the frosting. Dry sand and air, at about 1 lb. pressure, are used for ordinary work, and very fine sand, with steam at about 20 lb. pressure, for the best class of this work. The globes are replaced with expedition, and from 60 to 100 may be completed in an hour.

Bellows machines for marking labels through stencils on small ware are worked by manual and hydraulic power. One (Fig. 5) has a heavy, cylindrical

FIG 5



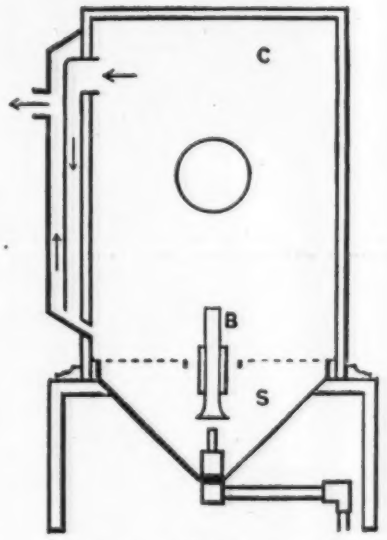
plunger, A, within the drum, D, the upper ends of the two connected by vulcanized India rubber, which peels off from the one to the other as the plunger reciprocates, making an airtight and practically frictionless joint. Below, the drum has inlet and outlet valves, and externally to the former, the sand blast. The base of the blast pipe, of 1⅛ inches bore, is surrounded by a cup, S, pierced with holes below, and beneath there is a vertically adjustable plate or disk. The sand placed in S falls on the plate, and is carried up by the inrush of air between that and the lower end of the blast pipe to strike the work; it then falls and collects in the base of the drum. The plunger is raised for every impression, the lever worked by an assistant, sometimes by standing his weight upon it; in smaller machines, it is placed close to the blast, and worked by the left hand, and the objects to be frosted changed by the right.

These machines—one of which is before us—are among those used for marking publicans' half pint glasses, after verification, at the four principal Weights and Measures Offices of the London County Council. The marks are given through a steel stencil plate, and in any one such machine, worked by two men, at the rate of 650 per hour, the cost for wages being 1s. 6d. per 1,000 glasses. From particulars kindly given me by Mr. Alfred Spencer, chief officer of the Public Control Department, London County Council, it appears that, in the year ending December, 1894, 575,942 such glasses were marked at these four offices alone. Inclusive of these, the total number of measures of all kinds submitted for marking in the County of London, during 1894, was 1,032,382; of these 773,168 were verified and marked and 259,214 rejected.

Granulating designs with overlays and frosting on moderate sized works in metal is generally conducted within a closed drum or box glazed on one or more sides to watch progress, and with holes in the sides of the box with elastic sleeves for the hands to hold the work in the vertical sand blast.

Fig. 6 shows on an enlarged scale the upper part of a small apparatus by Messrs. Coldwell and Davis to

FIG 6



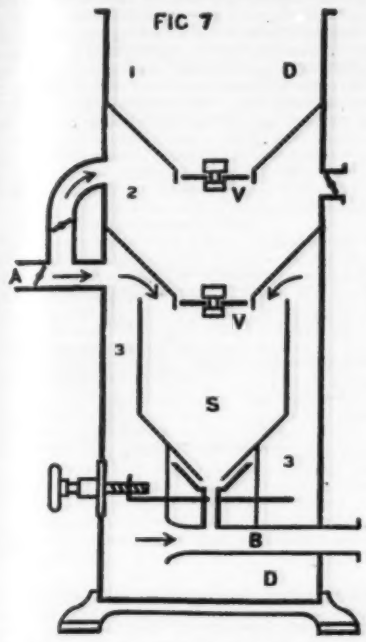
be used presently, which brings the practice of this decorative art on glass and metal within the reach of the amateur. The air jet is produced by bellows in the pedestal, worked by a treadle, and passes upward through a conical basin, S; its nozzle tube of three-sixteenths aperture, and the trumpet-formed base of the five-eighths blast pipe, B, are adjustable one toward the other, and the sand supply in the basin covers about one-half the length of the blast pipe. A tube and cover outside the case, C, provides the air outlet; most of the spent sand strikes the top of the case and falls back into the basin; that carried away with the air collects and falls back through a slit at the base of the air tube cover, practically none escaping. The pieces of work are arranged on a wire netting over the basin, and with the casing replaced, are picked up one by one and laid down as completed. Small work is introduced piece by piece in the fingers through one of the sleeve holes.

For large works in metal, from the removal of scale from castings and forgings, and obtaining uniform clean surfaces on plates for galvanizing, tinning, etc., up to the heaviest, the production of such surfaces on armor plates—the last previously effected by planing and other expensive methods—it is generally necessary to take the sand blast to the work instead of the work to the apparatus. Compressed air is then generally employed—a means of propelling the abrasives which bids fair to supersede all others. The plant on a larger scale, but otherwise the same as that before us, is driven by any convenient power, and consists of an air compressing pump, a store chamber for the compressed air, and the blast apparatus; the last alone needs description.

The external cylinder, D (Fig. 7), is divided into three compartments, two airtight and the topmost open above. The sand, shoveled through a sieve in this last, falls through valves into compartment 2, thence through similar valves into the open-mouthed sandbox, S, fixed in compartment 3, and from this through a funnel-mouthed pipe into the open end of the delivery pipe, B. The compressed air enters A, fills compartment 3, inclusive of the space above the sand in the box, S, and drives the sand as it falls from the latter along B to the blast pipe, a piece of plain chilled iron or steel tube from ¼ to ⅝ inch bore, which is held in the hand at the further end of a length of flexible tubing attached to the end of B. The sand in

8 being in equilibrium as regards pressure of air, falls freely by gravity; its volume regulated by a screw sliding valve, the head of which is outside the drum. Compartment 2 is also filled with compressed air from a branch of the pipe, A, but this is allowed to escape to open the valves in 1 every time fresh sand is added,

FIG 7



so that the issue of the sand blast is continuous and uninterrupted.

Mr. Redman, of the Allan and Hill lines, used a compressor giving 60 cubic feet of air per minute, driven by the ship's donkey engine, a 15 cubic feet storage chamber, and builder's sand, issuing at 10 pounds pressure from the $\frac{1}{4}$ nozzle of a corresponding blast machine, in cleaning the between decks of the iron steamship Austrian, 3,882 tons burden, a cattle boat, from many years' accumulated coats of hard sea paint, more than an eighth of an inch thick. The example is interesting, because the tough thick paint precisely resembled and resisted the sand blast, just as do the overlays used to neutralize its action on glass and stone; hence, the pace was slow, about 12 or 14 square feet per hour. But the paint was entirely removed down to the clean metal, and, as I was assured by the operatives, far better in angles and around bolt heads than they could possibly have done it in their accustomed manner with hammers, chisels and scraping.

The sand blast machine was then replaced by a cognate apparatus, patented by Mr. Redman, containing mixed oil paint; the latter atomized therein and blown as spray by the compressed air through a hose and nozzle, after the same manner as the sand. The exchange of sand for paint is perfectly successful, a uniform coat of flatted paint being laid in the ship on a wall space of 60 feet by 5 feet per hour. A similar arrangement of air compressor, driven by 5 horse power, a chamber for the air, used at 15 to 20 pounds pressure, a receptacle for the air and paint to mix, nozzle, and long hose were used with enormous saving of time and labor in painting the buildings at the World's Columbian Exposition, Chicago.

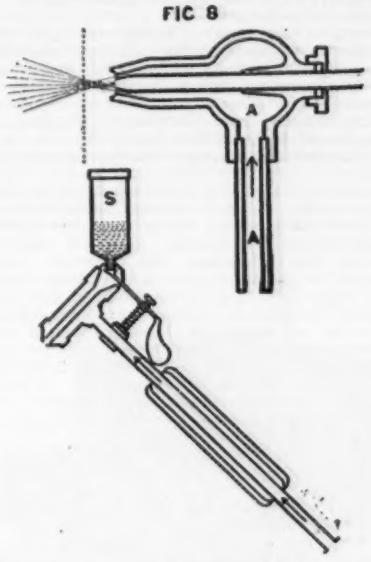
The sand blast used for removing the scale from steel armor plates at Sir John Brown & Company's works, Sheffield, has the air chamber of 15 feet capacity, and the compressor, driven by 3 or 4 horse power, making about 180 revolutions, will charge it at the rate of 60 cubic feet of air per minute. The steel blast pipe of $\frac{1}{2}$ bore at the end of the flexible tube, which latter is some 26 feet long, is held at an angle of about 20° to and at 3 or 4 inches from the armor plate, and with chilled iron sand issuing at 10 pounds pressure, the blast thoroughly cleans off the scale at the rate of one square foot per minute. The operator protects his face from the dust by a veil of fine wire gauze, or, with more comfort, by Mr. Mathewson's air helmet, one of which is on the table.

Tilghman's iron sand, just mentioned, is a remarkable abrasive formed of minute spheroidal pellets of hard chilled iron, produced by letting the molten metal fall through fine holes in fireclay, below which colander, in an atmosphere deprived of all oxygen, the streams are struck and atomized by jets of superheated steam; the resulting red hot globules drop into water and become chilled to intense hardness. Sifted into sizes, they vary from so minute as forty thousandths up to about one-sixteenth of an inch diameter. This material, of which Messrs. Harrison, of Middlesborough, have lent samples, is also extensively employed to replace sand and emery in sawing stone and granite.

A difficulty has always existed in the wear of the blast pipe, especially when its rear end is separated from the front end of the steam or air pipe, and the sand is picked up from the space between the two; Mr. Tilghman long ago pointed out to me that if these two pipes be not precisely in one axial line, the wear at once becomes excessive, necessitating frequent renewals. Wear is now nearly and ingeniously prevented in Mr. Mathewson's round and flat blast pipes, which postpone the mingling of the steam or air with the sand until both have issued from the nozzle. The shaded portion of Fig. 7 represents the pipe through which the sand arrives by gravity or otherwise; this is surrounded by the enlarged hollow head of the pipe, A, the one adjustable lengthwise within the other to determine the extent of the annular space between their open tapering ends; the air or steam rushing up A issues through this space, and converging, catches up and carries the sand forward, the two only mingling at the point shown by the vertical dotted line, well beyond the end of the nozzle.

Sharpening the teeth of files is a notable sand blast process. The teeth of files are formed partly by uniformly distant parallel cuts or indentations, in two series crossing one another, and partly by the burr driven up in making them with sharp chisel-edged tools and in machines. The file, pushed forward in the direction of the arrow, wears on the points of its

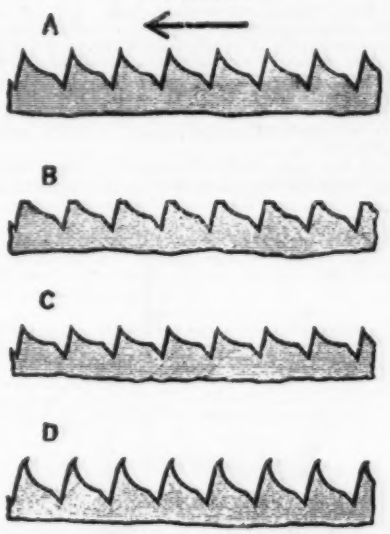
FIG 8



teeth, until they become so flattened, as at B, Fig. 9, that it will no longer cut. The only remedy was to soften, grind out the remains of the teeth, recut and reharden; expensive and objectionable in the reduction of the weight and thickness of the blank.

Worn-down files are resharpened in the sand blast by being slowly drawn several times from tang to point between two converging streams of fine sand and water—sand worn so fine in grinding plate glass as to have become valueless for that purpose, and a waste product, is preferred—projected by steam at about 60 pounds pressure, which pass on from the file into a receptacle for reuse. The effect is rapid, and on both sides of a flat or on all four sides of a square file simultaneously, a 14-inch rough or bastard file being resharpened in from two to three minutes; second cut and smooth files still more quickly produced by the sand-blasting away of the curved until they again meet the upright sides of the teeth, as at C, and at but little less angle than before. The file

FIG 9



throughout the process is drawn across a piece of gun metal fixed between the sand blasts, and the equal hang of the teeth to this "feeling piece" tells the operator the resharpening is uniform from end to end.

Worn-out files so resharpened—tried in the writer's workshops—prove nearly as good as new files on iron and steel, but owing to the small loss of angle in the teeth, less so on brass and gun metal, for which the workmen reject them.

Further, and as regards new files, it is found that the teeth do not always prove absolute points, but sometimes curl over, almost imperceptibly, toward the burr sides—shown exaggerated at D. A slight exposure to the sand blast at once removes this undesired hook-shaped burr, leaving the pyramidal points keen. Messrs. Charles Cammel, Turton, Sanderson, and other large file manufacturers, use the sand blast for this purpose.

Opinions long differed as to its value for new files. I have here a new ordinary 16-inch bastard cut file, one side of which has been sand-blasted and the other not—the means of holding this file at any inclination—and a block of gunmetal. I place the unsharpened face uppermost, and the block upon it, and will raise the file until the block slides, which it does at an inclination of about 23°. Leaving the file at this angle, I turn it over with its sand-blasted face uppermost, and replace the block, which now stands still; and I will again raise the file to the angle the increased sharpness of the teeth will retain the block, which appears to be 45°.

A 16-inch bastard cut file is sand-blast sharpened in 30 seconds; with a little longer exposure, the teeth may be made so keen that the file will retain the block until 70°; but such excess of keenness sacrifices strength, and the teeth become brittle. In practice, the best combination of sharpness and strength appears to be reached when the test block slips at 42° to 43°.

As a practical test, I am informed that a definite number of strokes, made by a practiced hand, with an ordinary new 14-inch bastard file, on gun metal, will remove a certain weight of metal (say 1·19), but that a similar new file, that has been sand-blasted, used by the same individual, under precisely the same conditions, will remove nearly twice as much (or 2·19). There is a less marked, but appreciable difference, on iron and steel, the figures being 0·988 to 1·2 on cast iron, 0·352 to 0·363 on wrought, and 0·674 to 0·758 on steel.

Sixty thousand dozens of new files, of all shapes, cuts and dimensions, were sand-blast sharpened for the trade at Tilghman's Sheffield works during the year 1894. The gross trade list value of these files was £63,680, and the charge for sharpening them was 2½ per cent. on such gross list value. The process being now largely used by many file manufacturers, it is estimated that—inclusive of this quantity—there were no less than 240,000 dozens of new files sand-blast sharpened during the same period in Sheffield alone.

The wet sand, and precisely similar apparatus (except that the two blasts strike the file at right angles instead of at about 20° to its surfaces, so as not to wear away the one side of the teeth), is now also very generally used for scouring new files, that is, for cleaning their teeth from the salt and yeast adhering after the process of hardening.

Many now also subject files to a short exposure to the sand blast from time to time during use, thus sharpening them like other tools, to prevent their teeth from ever wearing down to flats. Messrs. Platts, Beyer Peacock, Krupp, the Midland, the London and Northwestern, and other English and foreign railway companies, the Royal Small Arms Factory, Enfield, the German, Austrian, Japanese, and other arsenals and dockyards, and numerous other large users, include the apparatus in their plant solely for this purpose.

For stone, marble, slate and granite, the abrasives are sand, emery and chilled iron sand, delivered at from 10 to 15 lb. pressure, usually from the compressed air apparatus already described. The work, which we shall show you presently in operation, is at present confined to intaglio or incision at right angles to the surface, leaving the design on the ground in relief; there are several examples on the table. The overlays are similar to those for glass; if for original designs, they are cut of thick porous paper saturated with the glue and dextrine, by which also they attach to the plain or polished stone; for work often repeated they are frequently iron stencil plates. The quick, yet gentle action of the process annuls all risk of "plucking" or splaying the stone; but in some materials and marbles and in granite, which may be considered conglomerates, the harder are rather less cut away than the softer constituents; the sparkling granulation then produced is itself decorative, but, if required, it may subsequently be smoothed and polished.

The same apparatus is used for cleaning off the sooty weather deposits from stone, granite and brick buildings. Mr. Meikle, at Glasgow, employs a portable engine and the air compressor mounted on a truck for conveyance from place to place; an air chamber of 15 cubic feet capacity and a small sand blast apparatus, fixed on a railed stage raised or lowered by tackle, as used by painters; the air chamber connected by lengths of 2-inch vulcanized tubing to the compressor on the pavement below. The abrasive, sharp builders' sand issues from a half-inch nozzle at from 7 to 10 lb. pressure. The cleansing is thorough, and, I am told, can be confined to the grime, leaving the plain or carved surface of sandstone similar to that newly worked, and not even roughening the polish on granite. The inclusive cost does not exceed 1s. 6d. per square yard. There is a slab of sandstone before us showing the dirty incrustation, a portion cleansed by the sand blast, and a third portion subsequently treated with a coat of silicate solution, used by Mr. Meikle to prevent future deposits from again eating into the stone.

The antithesis to the work last mentioned, and, certainly, the most interesting sand blast process, that of engraving on lithographic stones for printing, was originated by the late Mr. J. L. Mills, and is now worked by his partner, Mr. Keep, of the firm of Gilbert Whitehead & Company, of London, by whose assistance I shall, in a few minutes, be able to show it to you in operation.

In ordinary lithography the design is drawn on the pure, smooth, polished stone in a greasy chalk or ink, and, although almost inappreciably, really stands just in relief; when printed from, the stone is kept constantly wet with water, which repels the ink—applied with a roller—from all parts of its surface, except the greasy lines of the drawing; upon these the water cannot stay, and they alone receive the ink and print.

In sand-blast lithography this is partly reversed. The whole surface of the stone is first impregnated with grease, so that, if then inked, it would print a uniform black; and this surface is then eaten away to a trifling depth with the sand blast, to entirely remove the grease from all portions that are not to print, that is, which are to give white; to granulate, or more or less destroy it upon those to give different tones of shading; and to leave it intact upon those that are to print black. All that remains of the original greased surface, therefore, alone prints; the stones being wetted, as usual, prior to inking for every impression.

Sand-blast engraving has been tried for steel-plate printing, and, although still in the experimental stage, it gives good promise of a future. The granulation from the fine emery powder gives the character of a mezzotint, but unlike an ordinary plate, upon which the rocking is generally uniform, so that it would print a solid block, and is then reduced in tones by scraping and burnishing to produce the drawing, the granulation of the sand blast may be localized and arrested on any portion at any depth of tint; thus reducing the subsequent scraping to a minimum. In printing, the plates are treated just in the ordinary manner; the whole surface is inked, wiped clean of the ink, and finally polished with whiting on the palm of the hand;

and then the ink, which remains only in the intaglio of the drawing, is transferred to the paper by the pressure of the rolling press in taking the impression.

A print from a stone, 19 × 13 inches, the drawing executed by Mrs. M. H. Earnshaw, is a good example of sand-blast lithography; it also shows the results of several aids used in the process, which must be briefly explained.

Old stones, long quarried, being more brittle, are preferred for sand-blast lithography. The smooth, polished surface is impregnated with oil and lithographic ink, and then rolled with a thin coat of ordinary Brunswick black varnish, the latter used only to produce a brown tone to enable the artist to watch the progress of his work, as the lighter tint of the stone shows more and more through the color; and, lastly, with the stone in a kind of open trough as a rest for the mahl stick, set up on an easel, the general proportions of the drawing are sketched in with chalk, as on canvas with charcoal.

The "sand pencil" generally used is a small copy of the nozzle, Fig. 8, shown on an enlarged scale below it. The stem, a ¼-inch pipe by 9 inches long, in a square wooden handle, carries a short tubular crosshead containing the sand delivery pipe; compressed air, at from 10 to 30 lb. pressure, enters the lower end of the stem from a slack vulcanized tube, and, for large drawings, the emery or other powder falls from a receptacle above through a similar slack tube into the large upper end of the delivery pipe, and the air, rushing out through the fine annular space at the orifice, catches and carries the emery with it. A valve, similar to that of a powder flask worked by the thumb, regulates the quantity or cuts off the abrasive, that air may be sometimes used alone. For small drawings the overhead sand supply is not used, and the abrasive is then contained, and falls from a cylindrical box, S, fixed to the upper end of the delivery pipe.

There have been several other modifications in details, and lately, an entirely new form. This last, a small cylinder, 4½ inches high by 1¾ inches diameter, contains the powder, and is a tiny, simplified copy of the compressed air machine used for armor plates. It is grasped in the left hand, the compressed air at from 5 to 15 lb. pressure enters from a flexible tube toward its upper end, and the sand or emery, regulated by a valve worked by the thumb, is ejected from its base through a lesser flexible tube to a pinhole steel nozzle fixed axially in the end of a rod the size of a cedar pencil, held in the fingers of the right.

Sand, powdered glass, emery, chilled iron sand and steel shot are used, according to the quality of the depressions required; but the sand pencils differ only in the bore of the delivery pipe from that of the finest pinhole to a quarter of an inch, and, in those so constructed, in that of a correspondingly increased annular space around the orifice. The pencil is held for the blast to strike the surface at about 45°, and is moved about closer to the stone in drawing lines further from it for wider, and at increased distances, no longer for lines, but for more and more dispersed functions, of which a sufficient repetition yields every variety of dark to light tints.

The ordinary acceptation of the word process, reproduction, does not apply; on the contrary, the artist records his original conceptions directly on the stone or plate, and is unfettered in manipulation. He can pass instantly from lines to broad shading with the same blast; he can use the abrasive best suited to bold or delicate work, and he can allow the full or diminished escape of that or of air; moreover, by numerous simple expedients he can localize the erosion with which he draws.

For example, if his subject be a head, portions—say the head, neck and chin—may be in full light against a dark background. If so, he commences by cutting out this outline in foolscap paper, and holding the paper down in position under the fingers of one hand, he plays the sand blast up and down its edge with the other, in a few minutes producing these portions in light and perfected outline. Such an outline in bright light is, however, too hard against a dark background, and in all drawing and painting has to be softened or rounded by tenderly working or stippling the color of each into the other throughout its length. With the paper abandoned, this labor is instantly accomplished by the sand blast, which, held fairly closed and passed along the outline, operates to either side of it and just sufficiently reduces the tone at the edge of the background as to destroy all hardness.

The artist then travels all about the drawing, lingering here and there, going and returning from one feature to another, the sand blast sometimes closer to and sometimes further from the stone, until, with marvelous rapidity, the whole head is perfectly ébauché in light and shade; the work executed in about a tenth part of the time in which it could have been so far drawn with chalk by hand.

To complete the drawing, numerous large to minute portions must remain of the tones already obtained; more must be reduced to lighter, and some, the high lights, to absolute white; the two former for the shadows, eyebrows, nostrils and the like, some of which must be strongly defined and others merge into lighter tones yet to be obtained, or again, for the roundings of cheek or neck where the gradations must be still more delicate. To obtain these effects and onward to the completion of the drawing, the artist resorts to repeated overlays in alternation with the sand blast. These are made by strokes and blots of ordinary white body color, freely laid on with a sable brush and quickly dried while making by the current of air with the emery cut off from the sand pencil; these touches are followed by reapplications of the sand blast, and are then all wiped off with a wet sponge to observe progress, and so on in repetition.

A single stroke of the pigment, used for delicate gradations, is partially penetrated by a light blow of the abrasive; but the thicker blots, built up to impasto by repeated touches, penetrate less and less to their central quasi-impervious portions and yield the nearly abrupt transitions for eyebrow or shadow; thus the actual touch or feeling of the artist is throughout instantly recorded with supreme fidelity on the stone.

This stopping out is carried further. Actual black, as for the pupil of an eye or any portion of a tint, is preserved intact by painting the shape with a tougher permanent overlay impervious to the blast. Actual white, by painting impasto all round it, or, quicker, by a paper guard cut with a hole to its shape and directing the sand blast into such apertures. Again, masses of pure white, as also delicate high lights in lace and draperies, are accurately preserved by first painting them on the pure polished surface in a mixture impervious to the grease, before that is used to impregnate the surface.

Lastly, flat even tints on backgrounds are obtained with ease by simply traversing the sand blast at a uniform pace and distance from the stone along the mahl stick, then lowering that and retraversing the stone in parallel paths from top to bottom, repeating this until a sufficiently light tint results. Graduated tones are produced by gradually curtailing the length of these consecutive traverses from the light to the dark side.

The print of a child's head—on the table—is a fair example of the delicacy in treatment obtainable in sand-blast lithography. On the wall are bolder specimens, well-known posters, executed with coarser abrasives, but otherwise with precisely the same means and in the same studio as the child's head.

The poster showing three life-sized figures, accessories and ornamental border, should be noticed, not only for its merits and for showing those of the sand blast in drawing, light and shade, varied textures and aerial perspective, but as an illustration of the remarkable rapidity of sand-blast lithography. It consists of nine sheets of paper, pasted up together, to give the complete picture, printed from nine separate stones, each measuring 60 by 40 inches. The drawing on these stones, from the first touch to their final completion ready for the press, was executed in rather less than nine days.

To conclude—this paper has but briefly described the sand blast processes in daily extensive use; to its many other applications—less generally practiced—time has not permitted allusion; and, I venture to think, wide as is its present range, there is little doubt the sand blast will find yet further use, both in the arts and manufactures.

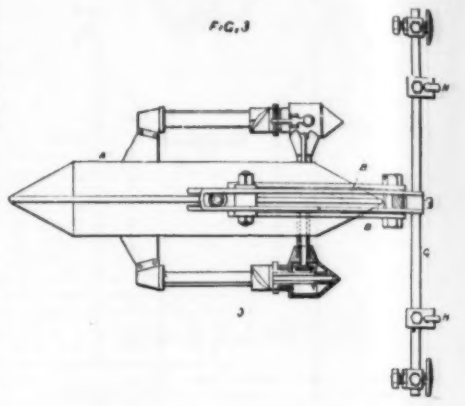
The sand blast process was shown in operation on glass, stone, granite and metal by Mr. Hole, Mr. Mathewson and Messrs. Coldwall and Davis; and, in lithographing drawing, by Mr. Keep.

The paper was further illustrated by very numerous specimens of sand blast work and decoration on glass, stone and metal.

AN ELECTRIC RUDDER MOTOR.

ALTHOUGH the application of electric energy for the purpose of propelling small boats has already made considerable progress, as may easily be seen in the summer upon the Thames, yet the cost of electric plant for pleasure boats has put it out of the reach of a great number of people. Hitherto it has been necessary to order specially built electric launches, as there appeared to be no practicable method of adapting ordinary rowing boats to such use without expenses disproportionate to the end in view. Many schemes have been brought forward to lessen the cost of upkeep for such boats, and from time to time some type of primary battery is brought forward, and the public is asked to believe that at last a cheap and efficient method of producing electric energy has been found. Messrs. New & Mayne, of Palace Chambers, Westminster, and of Woking, have, however, developed an entirely new method of applying an electric motor for boat propulsion.

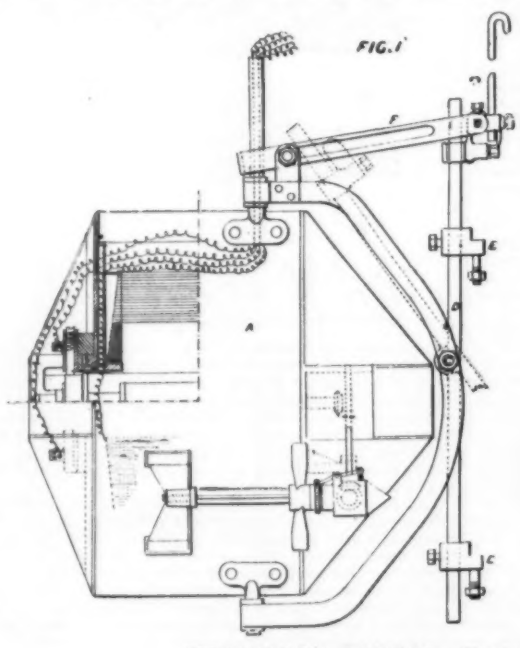
One of the chief difficulties up to the present has been the construction of an electric plant which could be placed in any ordinary rowing boat. The makers have carried out numerous experiments, and have at last produced a combined motor and rudder which seems to bid fair to fulfill the requirements. The complete apparatus is shown in Figs. 1, 2, and 3, Fig. 1 being a side elevation, Fig. 2 an end view and Fig. 3 a plan. A specimen is now on view at the Yachting Exhibition, at the Aquarium, where it is shown at work in a glass tank. It is merely, however, shown rotating, and not upon an actual boat in motion. The portion, a, consists of a water tight brass case inclosing the motor. This case is diamond shaped in cross section, and swivels upon a pin at the bottom and a vertical hollow shaft at the top. The whole case acts as a rudder, and is carried by a bent frame, b b, consisting of two flat bars of iron. The frame, b, is pivoted at c upon a stout bar, d, which carries two adjustable brackets, e e', provided with pins. These brackets are placed at a suitable distance apart to suit the particular boat in use, and the pins are dropped into the fixed eyebolts at the stern of the boat, which usually support the rudder. Proper adjustment in the vertical plane is obtained by means of the slotted rods, f. A cross bar, g, is provided with two hooks, h h, which can be adjusted so that all the weight is taken on the taffrail, and two adjustable pads are provided at the ends. We understand that the hooks are not needed at all for the smaller sizes. The particular apparatus illustrated is intended for a double sculler, such as is generally used for four persons. The motor is shown partially in section in Fig. 1 and also in Fig. 2. In size the armature is 3 in. diameter, and the commutator 2¼ in. to 2¾ in. diameter. The field magnets consist of two broad bent flat plates of soft iron, upon which the shunt winding is placed in a taper form, owing to the very small space available. The commutator is at the stern end of the case, and the brushes consist of pieces of carbon of square section, each carbon being pressed up to its work by means of a zigzag spring.



The stern end of the case is made in three separate parts, so as to allow for easy inspection of the brushes. The whole of the casing and the screwed covers shown in Fig. 1 are of brass. The armature shaft carries at its ends near the boat a bevel wheel which gears with another bevel wheel and drives a vertical shaft, which again drives a horizontal shaft actuating the propeller shaft by bevel gearing.

It will be seen that the apparatus is a twin screw gear, and the arrangement of the propellers is very ingenious. The propeller shafts are hexagonal in cross section, and each propeller is free to slide upon its shaft. It therefore follows that the thrust of the propeller is taken against either one or other of the supporting brackets, according to the direction in which the boat may be traveling.

The leads are in our illustration shown brought down the rudder spindle, but an improvement has been made in the specimen exhibit at the Yachting Exhibition, and they are brought up from the stern end of the rudder case in a bent tube. A somewhat better arrangement of the slotted links has also been made, two bars in one horizontal plane being now used. A wooden yoke similar to that used for the ordinary rudder is fixed on the squared top of the vertical shaft, and the leads are carried into the boat by the yoke lines, so that they serve for steering. Power is obtained from a secondary battery, consisting of twelve cells, divided into two groups of six each, in series. Each group is fitted into a separate wooden case, 16 in. long by 12 in. broad by 6½ in. high, intended to be put under the rowing seat. Each case is stated to weigh 45 lb. in working order. The leads run separate from the yoke lines to the first case, and thence to the second by concentric cable. A regulating switch with resistance coils is fixed upon the cases nearest



ELECTRIC MOTOR FOR SMALL BOATS.

the stern of the boat, and a head light of 12 volts can be also worked from this group.

The cells are of a special type made by the International Electric Storage Company. The plates are of the pasted type with a grid framework, and are inclosed in a celluloid envelope. The whole surface of the plates is said to be active, and the grid is not touched by the acid.

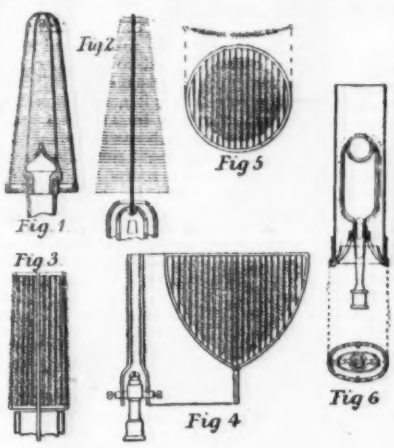
The cells are somewhat of the Tommasi type, and resemble to a certain extent the Therye-Oblasser make. In order that there may be no possibility of making the wrong connections between the cells of the motor, the end of one yoke line is fitted with a concentric square plug and the end of the other with a concentric circular plug. Each cell contains eleven plates, and the total weight of the battery, including the switch and resistance, is 112 lb. The motor exhibited is stated to weigh 60 lb., with case and supports complete; but a new type for the same size boat is to be built weighing only 50 lb.

The makers state that when worked in air the motor makes 2,000 revolutions per minute and the propellers 1,200 revolutions, and in water the propellers make 900 to 1,000 revolutions per minute. When used upon a double sculler of ordinary size, carrying four persons, the speed attained in still water is given as four to five miles per hour, and the battery contains a charge sufficient for eight hours. The motor described is the smallest type at present made, and if the case can be kept properly water-tight in practice, we think here should be a future for the apparatus. These plants could be let out on hire by the day to owners of boats by some persons having an electric charging station. There is less interference with the seating capacity of the boat than with any other driving mechanism we have yet seen. Of course all such electric apparatus suffers, and so far as we can see at present, must suffer, from the disadvantage of not being a prime mover.—The Engineer.

RADIANT TISSUE FOR INCANDESCENT GAS LAMPS.

By F. DE MARE, of Paris.

THIS invention relates to a process of manufacturing "a radiant tissue" in different shapes (sleeves, cones, sheets, yew leaf, etc.) of refractory material, "in the greatest degree of tenuity and solidity compatible with their employment." In principle it consists in "holding in suspension, or in dissolution, in a collodoide, the oxides which are difficult to reduce or volatilize—such as those of zirconium, erbium, yttrium, silicon, etc." The patentee proposes to utilize the property which certain of these metals possess of forming an ethyl compound, which, being mixed with alcohols, is able to form a collodion by the dissolving of a certain quantity of azotic cellulose. This collodion (the solvent of which is a mixture of one or more of these ether compounds and of alcohol, which may or may not hold in suspension or solution oxides or salts of these oxides) is drawn into a thread more or less fine, by its passage through a draw plate, either in free air or in a liquid suitable for hastening its solidification. It is with the thread thus obtained that, by the ordinary methods, sleeves, cones, sheets, etc., are woven, which subsequent heating deprives of organic matter, leaving the oxides in a state of molecular subdivision which facilitates their irradiation, while at the same time the continuity of the texture insures great solidity and durability.



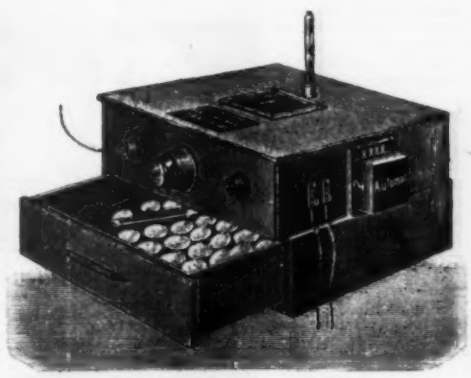
With very fine metallic wire (of platinum, for example), which constitutes the warp of the work, and threads of the radiant tissue, what is called in embroidery a chenille is made—that is to say, a collection of threads more or less fine radiating from the warp. This chenille, which is made in long lengths, is trimmed into the shape of lengthened spindles; and the warp may be even bared between each spindle. The length of the spindle is equal to the length of the radiant surfaces; and the slope of the spindle is calculated so that, according to the dimensions of the surfaces required (cones or disks), the radiating threads of two neighboring spindles may touch.

For example, the formation of a cone would proceed as follows: On a light ring of thin metal, and having a diameter slightly larger than the burner on which it is to be made radiant, a series of spindles is fixed, using the bare part of the warp—that at the lower part for fixing it to the ring, that at the top of the spindle to form at the top of the cone the supporting ring. This arrangement insures great solidity on account of the presence of the metallic warp; while at the same time it permits the use of very fine threads for increasing the surface of the radiant material. Expansions are free; and the surfaces can be either suspended or rest on their base, without fear of collapsing.

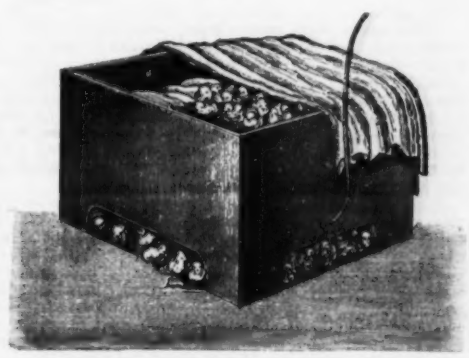
As regards the shape to be given to the radiant surface, it must be the same as the flame, and of slightly larger dimensions—flat for wing burners; cylindrical or conical for burners of the Argand type; semicircular for recuperative burners. The conical yew leaf form is equally suitable for lighting, provided that the burner is suitable—such as in the present inventor's "ejector burner."

In the accompanying illustration, Fig. 1 is a cylindro-conical sleeve applied to this last named system of burner. Fig. 2 shows the tissue in leaf shape, set in the center of such a burner. Fig. 3 is a slightly conical sleeve, applied to a Bengal or Argand burner. Fig. 4 is a front and side view of two parallel frames, applied to a wing burner. Fig. 5 is a plan and section of a frame intended for a recuperative burner. Fig. 6 shows a burner provided with a gauze of radiant thread arranged in the flame, shown in elevation.

Referring to these several forms, the patentee remarks: "In pursuing my tests on the manufacture, and on the most suitable shape for my radiant tissue, I have been led to study that of the flame, and to conduct the gaseous jet through orifices suitably combined. I have especially endeavored, in combining these burners, to approach the form of the filament in incandescent electric lamps—that is to say, to obtain flat flames whose lengths are greater than their widths—in which I insert a filament of my tissue either in chenille with platinum core or a series of wisps tied on this core, by a simple knot, or, finally, by lace chain also on a platinum core."



ELECTRIC INCUBATOR.



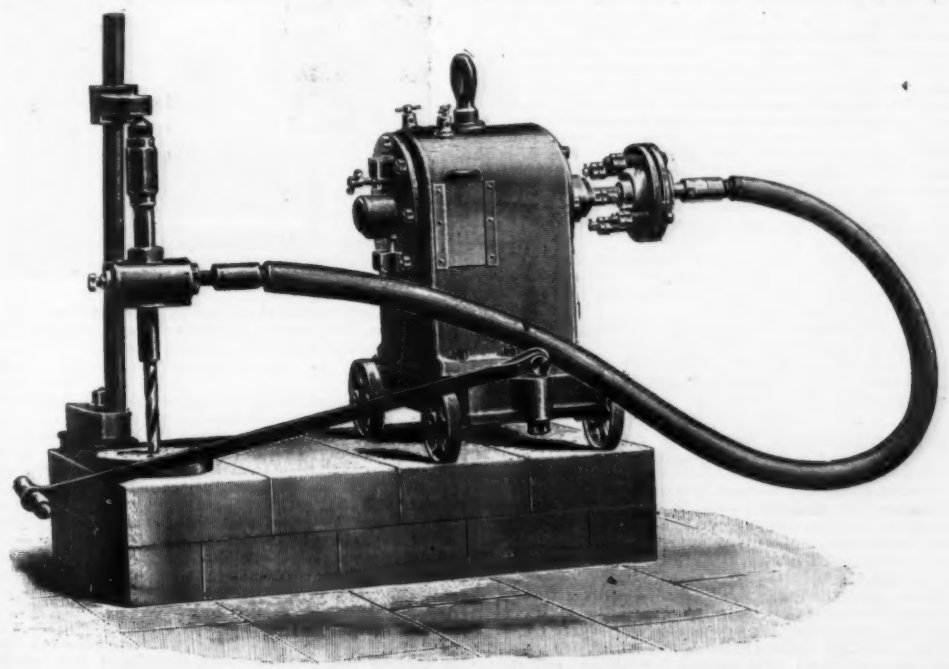
ELECTRIC MOTHER FOR CHICKS.

AN ELECTRIC INCUBATOR.

THE electric incubator shown in the accompanying engravings was constructed by Otto Schulze, an electrician of Strasburg, and is the result of three years of experimenting. The apparatus is made for 50, 100 or 200 eggs and is designed to obviate the difficulties connected with the ordinary form of incubator. The manipulation of the apparatus is very simple, and its maintenance depends only upon an uninterrupted supply of electricity. An automatic attachment keeps the temperature within one-tenth of a degree of the normal temperature of incubation. The degree of saturation of the air is kept in the same manner. Under ordinary conditions 90 chickens can be counted on out of 100 eggs incubated. The quantity of electricity required is very small, for an incubator holding 50 eggs 10 to 20 watts are sufficient, depending upon the temperature of the outer air. For raising the chickens after they are hatched an electric mother has been devised, as shown in our second engraving. The upper part is devoted to the freshly hatched chicks, while the lower part is arranged so that the chicks can run around on the ground and at the same time find heat and protection when they desire it. The electric incubator has proved very successful during the last winter. It may also be used in the culture of bacteria. For our engravings we are indebted to L'Energie Electrique.

PORTABLE ELECTRIC DRILLS.

PORTABLE electric drills are found to be extremely useful in workshops and on board ship for drilling or rimering holes. In the illustration below, from the Steamship, we show the type manufactured by Messrs. Ernest Scott & Mountain, Limited, of Close Works, Newcastle-on-Tyne. The electric motor is of the firm's improved type, incased with suitable gear, so that the brushes can be regulated from the outside. The spindle is fitted with a slipping clutch of an improved type, so that should too much work be put upon the drill, the slipping clutch will prevent the motor from being injured by an excessive current. The flexible shaft is of an improved type, and is fitted into a leather case. The drill head is of gun metal, so that it will stand rough usage, and contains the necessary gear for reducing speed. The drill socket is bored to the Morse taper. These electric drilling plants are very suitable for general workshop use, as they entirely avoid the hand drilling, and the work is much more rapidly and satisfactorily executed. The plant shown in the illustration was designed for shipyard use and intended for rimering the holes in oil ships, and also for any drilling in awkward positions. For the erection of bridges, girder work, and generally in all positions where there is much hand drilling to be done, drills of this description are found to give very economical results, as they can be driven from an ordinary electric light installation, and, if necessary, the current taken off the electric light wires. These machines are now largely in use, and the results obtained are of the most satisfactory nature.



PORTABLE ELECTRIC DRILLING MACHINE.

THE SLIT OF A SPECTROSCOPE.

By WILLIAM CROOKES, F.R.S.

ONE of the most important parts of a spectroscope is the slit, and the best material wherewith to fashion the jaws has been the subject of much thought and experiment in my laboratory for some years past. The substance chosen must be very hard, and capable of being ground to a perfect knife edge; it must not be granular in texture, or it cannot be worked to the required accuracy; it should not be brittle, or the cleaning which is occasionally necessary will be liable to break the fine edge, and it should be capable of standing any acid vapors to which it is liable to be exposed when left uncovered in a chemical laboratory in active work; it must also not allow light to pass through except between the jaws, absolute opacity at every other part being imperative.

The following extracts from a letter I wrote to my friend Dr. Schumann, in May, 1893, will explain the difficulties, and how they were finally overcome:

"You may feel interested in knowing the results of some experiments I have been lately making with the object of getting the best material for the jaws of the slit. I again tried iridium, using another piece of well-fused metal; but the old objection of granulation, when the knife edge stage was reached, was as great as in the former instance. Pure wrought cobalt gives a fine edge, and is very hard and takes a good polish; if nothing better could be got, cobalt would do very well, but I do not know if it would stand the ordinary atmosphere of a laboratory for any long time without tarnishing. Manganese steel is even harder than co-

bait, and from what I have seen will make as good an edge; but here the liability of tarnishing is still greater than in the case of cobalt.

"I have recently been making the jaws of my slit of transparent quartz, and I find this answer so perfectly that I cannot conceive anything better. Each jaw of the slit I am now making for the new spectrograph is 25 mm. long, 13 mm. wide and 4 mm. thick; it is beveled off along one edge at an angle of 45°, thus:

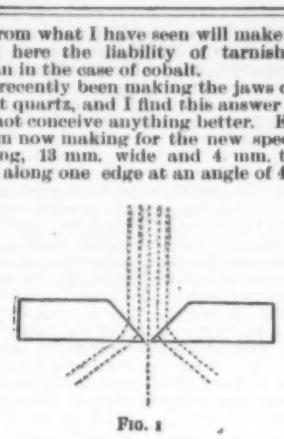


FIG. 1

"The sides and angle must be ground true and polished. At first I had great difficulty in getting the knife edge true. In the final grinding and polishing small splinters occasionally broke off the edge, and then I had to recommence the grinding and polishing to get rid of these little flaws. It is difficult for me to fashion a knife edge of quartz at an angle of 45°. Ultimately I got over this difficulty by putting a very narrow bevel on the front of the plate, so making the angle of each jaw 90° (see Fig. 2).

"You at once see that no light can get through the part of the quartz which is cut at an angle, owing to refraction, and the light coming through the flat part of the quartz plate can easily be stopped by a metal diaphragm or film of black varnish. The edge made in this way is absolutely black and opaque even in sun light, and it will bear a high microscopic power without showing the least irregularity. I clean the slit from dust by opening it about a half a mm., and passing a splinter of soft wood between the jaws. I have not yet put a micrometer to the quartz slit, but I see from preliminary experiments that I shall be able to work with a much narrower slit than I could if I used a metal one. It is very beautiful to see the absolute opacity and trueness of edge of one of these slits when examined under a high power."

I have now used nothing else but quartz jaws since the above quoted letter was written, and when properly made I consider them perfect. Besides quartz, several other hard crystals were tried. Sapphire makes good jaws, but being so hard, there is corresponding difficulty in getting the edge true; it is also more difficult to get plates of sapphire quite transparent, and in this case perfect transparency is the essential for perfect opacity, for a transparent angle refracts all the light passing through it, and throws it on the side of the tube, where it is cut off by a diaphragm, whereas a semi-transparent or cloudy crystal disperses some of the incident rays irregularly and makes the background of the image of the slit not absolutely black. In fine spectrum work any stray light illuminating the background is liable to obscure the visibility of faint lines. I tried an edge of a cut diamond, and it answered well, but quartz being hard enough, and so much easier to work, it is not necessary to go to harder crystals.

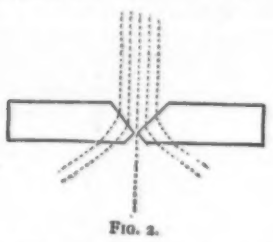


FIG. 2.

If the jaws are cut and polished by a lapidary, the workmen must be warned not to flatten the sharp edge to hide irregularities. I have had several jaws spoiled that way. The flat face thus formed reflects incident rays, and those of them which are at a sufficiently acute angle to find their way down the tube to the collimator and prisms introduce false light and possibly false lines. The edges of the jaws must be quite straight, so that when they come together they cut off the light at once along the whole length of the slit. This is very difficult to secure, and is one of the reasons why I make the jaws from plates 25 mm. long. The actual length of working slit not being more than one-quarter of that length, it is easy to select sufficient from each jaw to get 5 or 6 mm. of quite straight edge, even if the whole length is not perfect.

With the pair of jaws in the spectrograph at present in use I can take excellent photographs when they are only 0·0001 inch apart. For eye observations the width can easily be less than that.

Some advantage is gained by making the knife edges of well melted quartz. This material is tougher than the crystal and is not so liable to splinter. There is, however, a little difficulty in getting it free from air bubbles.—Chemical News.

PROJECTIONS BY THE OXYETHERIC BLOWPIPE.

IF one needs an intense light for projections or for photographic amplifications, it is necessary to have recourse to the electric or the oxyhydrogen light, but distributions of electric energy do not as yet exist everywhere, and illuminating gas itself is wanting in many cases.

It is true that gas may be replaced by the flame of an alcohol lamp. In this case one employs an oxyhydrogen blowpipe especially constructed to this effect, but the light given by alcohol and oxygen is less intense than that obtained with the oxyhydrogen blowpipe. Different attempts have been made to supply the blowpipe with atmospheric air rendered combustible by its passage through or over a carbureting liquid, but the apparatus have been more or less complicated and the results have left much to be desired. The idea has occurred, too, to carburet the oxygen itself by the aid of ether or the light essences of petroleum.

At first, the oxyetheric light was obtained by causing the oxygen to pass into a carbureter containing ether in a liquid state. The first experiments made with apparatus of this kind were not unaccompanied with some danger.

Toward 1882, the first improvement was made in saturators by providing them internally with spongy substances, so that the ether was no longer in a free state. Such apparatus operated like the gasoline lamps now so commonly employed, but the quite active evaporation quickly led to a rapid reduction of the temperature, and as the oxygen was no longer sufficiently carbureted, the apparatus was unsatisfactory. So one was led, especially in the cold season, to seek for a method of heating the apparatus. After various experiments, the saturator was finally placed in the lantern, and several apparatus have, within the last two or three years, been constructed upon this principle.

Among such apparatus, the one that Mr. Molteni has adopted and that he has taken upon himself to construct appears to present the desired conditions for a proper operation.

The oxyetheric blowpipe represented in Fig. 1, and which consists of a cylinder divided into two or more compartments containing the substances designed to absorb the volatile liquid, constitutes the saturator properly so called, after which are fixed the blowpipe and its accessories. The general arrangement, forming a compact whole, operates as follows: After the apparatus has been filled with ether or gasoline, it is inverted in order to drain off the excess of liquid, and then turned right side up. After the screw plug that closes the reservoir has been inserted, the tubulure that is observed at the bottom and to the right of the figure is put in communication with the oxygen reservoir by means of a rubber tube. The tubulure is soldered to a T-shaped tube in which the oxygen is divided into two portions, one of which passes through the saturator, becomes carbureted and flows to the exit of the blowpipe, where it is lighted like illuminating gas, while the other goes directly to the blowpipe and acts precisely like pure oxygen in ordinary blowpipes to form the flame that heats the lime to incandescence. The flow of the two currents of oxygen is regulated by means of cocks or screw valves placed upon each branch of the T-shaped tube.

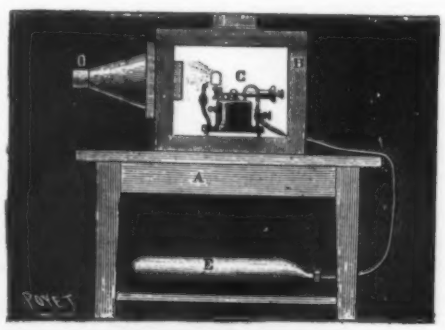


FIG. 2.—Arrangement of the Oxyetheric Blowpipe, C, in the Projection Lantern, B. O, objective; A, supporting table; E, oxygen tube.

The advantages of this mode of lighting are the following: The possibility of having an intense light in places deprived of illuminating gas; ease of carriage; simplicity of maneuvering; a greater intensity than that of the oxyhydrogen light; and smallness of size of the luminous point and, consequently, an increase in the sharpness of the image.

Fig. 2 gives a general view of the oxyetheric lamp arranged in the projection apparatus. The blowpipe is represented at C with the incandescent stick of lime. It is placed in the center of the projection lantern, B, whose objective is figured at O. The entire apparatus is placed upon the table, A, beneath which is placed the oxygen tube, E. This new system, which we have experimented with, appears to us to be very recommendable.—La Nature.

[NATURE.]

ISOLATION OF FREE HYDRAZINE, N_2H_4.

M. LOBRY DE BRUYN contributes a memoir of special interest to the current issue of the Recueil des Travaux Chimiques des Pays-Bas. It is not long since the distinguished Amsterdam chemist succeeded in preparing for the first time free anhydrous hydroxylamine, and now he announces that he has likewise been successful in isolating free hydrazine by a similar method.

Eight years ago the important discovery of hydrazine was made by Prof. Curtius, and since that time the amount of knowledge which has been accumulated concerning the base and its compounds by Prof. Curtius and his assistants is so large that a separate volume might well be devoted to it. Nevertheless, the free anhydrous base itself has not hitherto been satisfactorily prepared; indeed, it would now appear, in the light of M. De Bruyn's remarkable work, that it has not hitherto been in any way isolated. The hydrate of the base has been obtained in the pure state and fully described by Prof. Curtius, but in his later communications he has expressed the view that the free base is so unstable that most probably it is incapable of separate existence. The hydrate only is produced when the salts are decomposed by a caustic alkali, and even digestion in a sealed tube at 170° with anhydrous baryta has failed to detach the water molecule from its combination with hydrazine. It appeared, however, to M. De Bruyn that the nature of the salts and other compounds of hydrazine rendered it scarcely probable that the base was less stable than hydroxylamine, and he considered it not unreasonable to hope that it might, therefore, be isolated in an analogous manner to the latter base, namely, by reacting upon the chloride with sodium methylate in methyl alcohol solution. The experiments made in this direction are only preliminary, but their result is so interesting that an account of them is at once published.

The salt employed was the chloride $N_2H_4.HCl$, prepared as described by Prof. Curtius. Ten grammes of this salt in powder were added to 200 c. c. of pure methyl alcohol, and a solution of the calculated quantity of sodium methylate CH_3ONa in methyl alcohol was subsequently added. Common salt was immediately precipitated without any perceptible rise of temperature. The mixture was consequently boiled for half an hour in a flask fitted with an upright condenser. After cooling the sodium chloride was removed by filtration, and the solution submitted to distillation. At first mainly methyl alcohol passed over, but after a time the distillate began to contain augmenting quantities of hydrazine; the pressure was then reduced, and four further quantities separately collected. The temperature of ebullition rose to 55°, although the pressure was materially reduced. The last 20 c. c. contained the greater portion of the base. This last fraction was then again distilled at the ordinary pressure, until a residue was left which contained 73 per cent. of hydrazine. The hydrate of hydrazine only contains 64 per cent. of the base; hence it was evident that some free hydrazine had been obtained, and that hydrazine is a comparatively stable substance boiling at a temperature higher than that of methyl alcohol.

In a second experiment forty-two grammes of chloride of hydrazine were treated in a similar manner with methyl alcohol and sodium methylate. This larger quantity evinced some rise of temperature after the admixture, and the heat caused by the reaction of the hydrazine chloride, which at first had not all dissolved, was just sufficient to keep the liquid boiling for several minutes, when once it had been brought to the boiling point by extraneous heating. After the conclusion of the reaction the contents were cooled, avoiding the access of moisture and carbon dioxide, the sodium chloride filtered off as before, and distillation proceeded with, at first in an ordinary distillation apparatus and afterward with the aid of a Le Bel-Henninger apparatus. A residual 40 c. c. was again fractionated under reduced pressure and six portions collected. The sixth fraction contained no less than 82·6 per cent. of N_2H_4. A smaller quantity passing over after removing the sixth fraction contained over 84 per cent. The fifth and sixth portions solidified when cooled by a freezing mixture of ice and salt. The crystals melted about 4°. Although the crystals when exposed to the air exhaled dense white fumes, owing to the attraction of moisture, a number of them were quickly pressed between cooled blotting paper, weighed, and volumetrically analyzed. The analytical numbers corresponded to 92 per cent. of N_2H_4, a result which, considering the extremely hygroscopic nature of the crystals, would appear to indicate that they

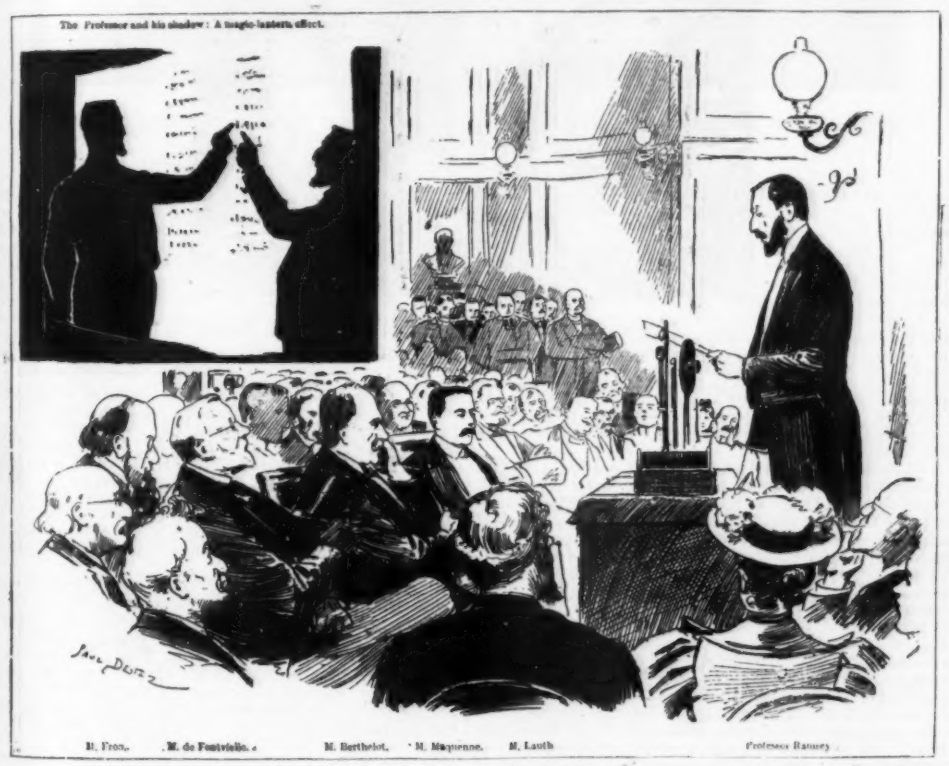
consisted of practically pure N_3H_5. The dried crystals melted at $-1°$ to $-2°$.

A drop of the liquid obtained by fusion of the crystals did not explode when heated with a naked flame; a yellow flame was produced, however, accompanied by a hissing noise. The liquid base is heavier than water and considerable heat is evolved upon mixing it with a small quantity of the latter liquid. Dry oxygen slowly oxidizes it. When paper is moistened with a drop of hydrazine and exposed to the air, it becomes hot spontaneously and fumes strongly. Crystals of sulphur dissolve promptly in the liquid base with considerable rise of temperature and formation of a reddish brown liquid whose odor reminds one of ammonium sulphide; upon the addition of water to this liquid, sulphur is precipitated. The halogens react very violently with hydrazine, producing their acids, and liberating nitrogen. Iodine disappears instantly, and a quantitative experiment showed that the reaction proceeded in accordance with the equation $N_2H_4+2I_2=N_2+4HI$. Potassium permanganate or bichromate acts with great violence upon the liquid base, but the reaction is unaccompanied by either incandescence or explosion. The liquid appears to possess the further property of readily dissolving many salts, such as the potassium salts of the halogen acids and niter.

It would thus appear that, instead of being a gas, as at first supposed by Prof. Curtius, free hydrazine is at the ordinary temperature a liquid, which, however, solidifies at a temperature in the neighborhood of that of the freezing point of water, to colorless crystals. The base is, moreover, endowed with a very much higher degree of stability than was supposed. M. De Bruyn is now engaged in preparing it upon a very much larger scale, in order more completely to study its properties. A. E. TUTTON.

ARGON AND HELIUM.

RECENTLY, about four hundred French scientists and one hundred ladies filled the large hall of the


The Professor and his shadow: A magic-lantern effect.
M. Fron. M. de Fontviolle. M. Berthelot. M. Maquenne. M. Lauth Professor Ramsey

PROFESSOR RAMSEY LECTURING IN THE HALL OF THE FRENCH SOCIETE D'ENCOURAGEMENT, PARIS.

building belonging to Le Société d'Encouragement—a French equivalent to the British Society of Arts—Paris, when Prof. Ramsey delivered a lecture on argon, the newly discovered element in the atmosphere. Prof. Ramsey spoke fluently in excellent French.

The general properties of argon having been previously explained to the Academy by M. Berthelot, and described by almost every French paper, the speaker confined himself to narrating the circumstances of the discovery and the peculiarities of argon. In the more abstruse parts of his lecture Prof. Ramsey was assisted by a magic lantern.

The concluding portion of the lecture was devoted to a discussion of the hypothetical presence of "helium" in company with argon, in a rare mineral from Norway. A hand spectroscope had been placed for the purpose on each side of the chair, exhibiting separately the rays of argon and the rays of helium. At the conclusion of the address, the whole of the audience broke into a loud round of applause, while Prof. Ramsey handed over to M. Berthelot a glass tube full of argon and helium, in order that the great French scientist might make fresh and crucial investigations.

CHEMICAL BEHAVIOR AND USE OF ALUMINUM.*

THE action of distilled, of filtered river, and of spring water, upon carefully cleaned strips of aluminum sheet, are first described. The strips were boiled for forty-eight hours in beakers in contact with the water under test. In the case of distilled water, the surface of the metal remained bright excepting where it had been more or less exposed to the air, and here it was covered with a faint veil of white deposit, and was slightly deadened; but the strip had only lost 6 milligrammes on 8·3832 grammes. The addition of merely a few c. c. of pure but weak hydrogen peroxide solution to the distilled water caused an immediate deadening and darkening of the metal, and the water became visibly turbid from the presence of a light precipitate of alumina.

The production of hydrogen peroxide by the combined action of air and water upon aluminum, described by Mylius and Rose (as by their analogous joint action upon zinc, quoted by Traube in this Journal, 1890, 213), would account for the slight attack above described; so that the action of pure water upon dense aluminum may be regarded as nil. But the filtered river water, and less markedly the spring water, soon caused a visible corrosion, accompanied by the production of rough, dark gray, black or brown patches, with here and there a white deposit, and of whitish flocks in the water; the plates immersed in the waters lost, respectively, 0·0007 gramme on 7·2531 grammes and 0·0361 gramme on 7·5415 grammes. Experiments with the filtered water, repeated at different seasons of the year, always gave similar results; but the intensity of action varied, the brown and gray patches predominating in spring, when the water contained most nitrates, and the white being most in evidence in summer, when nitrates and nitrites were practically absent. Experiments were next made to determine which ingredients of the water produced the corrosive action.

Alkaline chlorides and sulphates are generally said to have no action, and the same has been proved by Neumann-Wenden for carbonic acid and bicarbonates. A nearly saturated solution of calcium sulphate showed no corrosion, but of solutions containing 0·3 gramme of magnesium sulphate and 0·26 gramme of the chloride per liter, respectively, the former showed a just perceptible alteration, the latter a distinct and uniform corrosion of the aluminum surface, but without brown or gray patches, and without the formation of a precipitate in the solution. But solutions containing as little as 0·01 gramme per liter, respectively, of potassium and ammonium nitrate, and of potassium nitrite, produced a strong alteration analogous to that given by the natural waters. The influence of the organic constituents of the water could not well be observed, because they could not be separated from the accompanying metallic elements, and being of very variable (and largely of unknown) constitution, they could not be imitated artificially.

But excluding the action of organic matter, it would seem from the above experiment that the effect upon similar aluminum plates of boiling with various samples of water for equal periods may give a fair general indication of the comparative hygienic characters of the waters examined. There would seem to be no objection to the use of aluminum for cooking utensils, for even when the highest degree of corrosion has been attained, but little alumina and iron pass into the solution; the dark colored patches being due to the formation of insoluble compounds of carbon, silicon, and iron, which are always present in commercial aluminum.

Aluminum is also recommended for use in the packing or treatment of fats or fatty acids. Experiments similar to those made with water showed that exposure for three days at 60° C. in contact with either rancid butter, palm oil, or raw oleic or stearic acid produced no effect upon the aluminum strips, even where they were exposed to the air. The immunity of so electropositive a metal may be ascribed to the feebly basic character of its oxide.

Lastly, melted anhydrous phenol failed to produce any perceptible corrosion of the aluminum, even after a 60 hours' contact, while a 10 per cent. aqueous solution of carbolic acid, after a like period of action at a boiling temperature, produced yellowish patches upon the metal, and caused a loss of 0·0051 gramme on 7·9501 grammes, which was doubtless due to the combined action of air and water, afterward assisted by the acid-like action of the phenol. Aluminum is therefore especially suited to the manufacture of condenser worms and packing vessels for pure carbolic acid.

* E. Donath, Dingler's Polyt. J., 1895, 295, 18-21.

COMPOSITION OF THE EXTINCTIVE ATMOSPHERES PRODUCED BY FLAMES.*

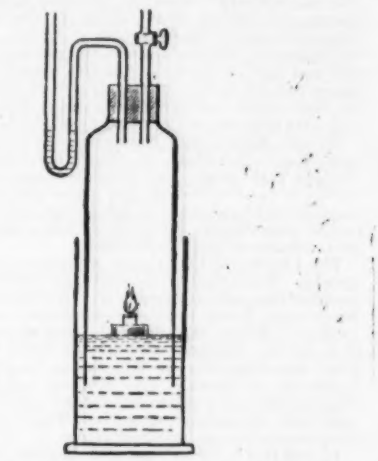
By FRANK CLOWES, D.Sc., London.

IN a former paper,† the author communicated the results obtained by mingling gases which were extinctive of flame, with air, until a flame burning in the air was just extinguished. The gases used in the experiments were carbon dioxide and nitrogen. Each of these gases was separately introduced into the air; and the composition of the atmosphere thus produced, which just extinguished flame, was determined by chemical analysis. The general results arrived at were:

1. That wick-fed flames require atmospheres of very similar composition to extinguish them; while gas-fed flames require atmospheres of widely different composition.
2. That nitrogen must be added in larger proportion than carbon dioxide, in order to extinguish the same flame.
3. That the minimum proportion of extinctive gas which must be mingled with air in order to extinguish a flame is independent of the size of the flame.

A supplementary series of experiments has now been undertaken in order to determine the composition of the atmosphere extinctive of each flame, which is produced by the flame itself when burning in an inclosed volume of air at atmospheric pressure. Preliminary trials showed that, in order to secure trustworthy results, the atmosphere must not be in contact with water. It was further found necessary to avoid change of pressure in the inclosed atmosphere during the combustion of the flame. These necessary conditions were complied with by allowing the flames to burn in a bell jar, the bottom of which was closed by dipping into a sufficiently deep vessel of mercury. The neck of the bell jar was closed by a cork bearing a U-shaped mercury gage, and a glass tube with a stopcock.

While the flame was burning, the pressure of the air within the bell jar was maintained uniform by raising or lowering the bell jar sufficiently to maintain the mercury levels unchanged in the pressure gage. As soon as the flame was extinguished by the atmosphere around it, the vessel was allowed to stand until the atmosphere within had become uniform in temperature with the air around. A portion of the gases within



the bell jar was then removed by means of the stopcock tube to a Hempel gas burette, and was subjected to ordinary volumetric analysis by absorption. Each experiment and analysis was repeated in duplicate, and frequently in triplicate. The results obtained were either identical or closely concordant, except in the case of methane; but the flame of ethylene could not be maintained under the conditions of the experiment. The gas was burnt from a tube passing through the mercury, and terminating in a jet just above the surface of the mercury. The liquids were burnt from wicks contained in small shallow vessels floating upon the surface of the mercury.

As in the previous series of experiments (loc. cit.), the combustible substances used were chiefly those which are burnt for ordinary heating and lighting purposes. The mean results are tabulated below:

PERCENTAGE COMPOSITION OF THE RESIDUAL ATMOSPHERE AND OF THE ARTIFICIAL ATMOSPHERE IN WHICH FLAME IS JUST EXTINGUISHED.

Combustible substances burnt.	Percentage composition of the residual atmosphere in which the flame was extinguished.			Proportions per cent. of O_2 and N_2 in which flame is extinguished when introduced.	
	O_2.	N_2.	CO_2.	O_2.	N_2.
Alcohol, absolute	14·9	80·7	4·35	16·6	83·4
Alcohol, methylated	15·6	80·25	4·15	17·2	82·8
Paraffin, lamp oil	16·6	80·4	3·0	16·2	83·8
Colza and paraffin	16·4	80·5	3·1	16·4	83·6
Candle	15·7	81·1	3·2	16·4	83·6
Hydrogen	5·5	94·5	...	6·3	93·7
Carbon monoxide	13·25	74·4	12·25	15·1	84·9
Methane	15·6	82·1	2·3	17·4	82·6
Ethylene (failed)	...	...	...	[13·2	86·8]
Coal gas	11·35	88·75	4·9	11·3	88·7

In the above table, the results are given which were obtained by the analysis of the residual atmospheres in which the flame had burnt until it was extinguished. Since the proportions of carbon dioxide contained in these atmospheres are small, the composition of the artificial atmospheres consisting of nitrogen and oxygen only in which the flames were just extinguished when they are inserted, are also stated for comparison. It will be noticed that the general agreement in composition shown by the two classes of extinctive at-

* Communicated to the Royal Society.

† Roy. Soc. Proc., Vol. LVI.

mospheres, so differently produced, is well maintained; and, when the conditions of the experiments are taken into account, the recent series of results are confirmatory of the general accuracy of those that were previously obtained.

After acknowledging the assistance rendered to him by Mr. M. E. Feilmann, B.Sc., in carrying out the experimental work involved in the above investigations, Professor Clowes proceeds, in a subsequent communication (dated February 18), to show how closely the composition of the extinctive atmosphere produced by the flame of a candle or of oil or alcohol corresponds with the average composition of the air expired from the lungs. The conclusions drawn from these experiments are that: 1. The flames of the combustible gases and liquids which were experimented upon produce, at the point of extinction in an inclosed atmosphere, a change in the proportion of oxygen in the air generally corresponding to that produced by preparing extinctive atmospheres by artificial mixture. 2. The flames of candles and lamps, when they are extinguished by burning in a confined space of air, produce an atmosphere of almost identical composition with that of air expired from the lungs. 3. The extinctive atmospheres produced by the combustion of the flames of candles and of lamps, and the air expired from the lungs after inspiring fresh air, are respirable with safety. 4. The extinction of an ordinary candle or lamp flame is not necessarily indicative of the unsuitability of an atmosphere to maintain life when it is breathed.

THE KHMER RUINS OF SIAMESE CAMBODIA.

THE structures erected by the ancient Khmers in Cambodia and Siamese Cambodia occupy an immense territory which is now overrun with forests. The ruins are spread out beneath a dense vegetation. The composition of the plans of all these extraordinary works and the originality of the sculptures and of the striking ornaments carved in the stone excite the curiosity of travelers to the highest degree. We should like to know the dates of the origin of these structures, which bear testimony to a refined civilization, but, unfortunately, nothing has been found up to the present that can tell us precisely the epoch at which these wonderful edifices were constructed. An important document, however, exists in the treasury of Norodom, the King of Cambodia. It is a royal chronicle, or Pongsa-Voda, consisting of two parts. The first of these gives an epitome entirely formed of fabulous narratives enumerating the events that occurred from the origin of Cambodia up to the year 1340 of our era. The second, beginning in 1340, extends to the modern period. The Chinese and Annamite annals, ancient manuscripts preserved by some of the chiefs of the Bonzes, are likewise capable of furnishing data, though uncertain, as to the first age of the country of the Khmers.

Messrs. Moura and Aymonier obtained permission from King Norodom to have a translation of the Pongsa-Voda made, and from a consultation of their works I have collected the principal facts that are capable of being used for assigning approximate dates to the remarkable structures that ornament the ancient capital of the Cambodians.

The history of Cambodia embraces three principal epochs. The original inhabitants consisted of savage peoples that are supposed to have been the Samres. They had faith in the mysterious worship of the serpent. These Samres were subjugated by an invasion of the Khams, who in the year 500 B. C. came from the kingdom of Khomerat, situated upon the frontiers of China. The Khams, mingled with the Samres, created a prosperous state called Kutch-Thloc, but they remained primitive. The dynasty of their kings lasted three hundred years.

In 443 B. C., Prea-Thong, a Hindoo prince, son of the King of Indraprastha (Delhi), in open revolt against his father, and driven by him from his country, was forced to emigrate to the south of Indo-China with a large number of his fellow citizens. He fixed himself at Coukhan, in Kutch-Thloc, bringing with him the ideas of progress and the artistic knowledge of the country of his origin. Prea-Thong and his companions were, like the Khams, Brahmans. Dissensions soon arose between these different peoples.

The Khams, having been conquered, retired to the provinces of Lower Laos. Prea-Thong, deciding to live in the country forever, married the daughter of one of the principal chiefs of Kutch-Thloc. He caused himself to be proclaimed king under the name of Preabat-Tivong-as-Char, and called his kingdom Crung-Kampuchea. These words, derived from the Pali, mean "kingdom sprung from the water."

The legend gives the fact in a fabulous manner. It presents the fiancee of the prince (Princess Suwan-Neakea) under the form of the daughter of the King of the Dragons, who had the power of commanding the waters of the sea, of making them recede to a distance, and of causing a palace and a fortress to emerge from the earth as a dwelling for the newly married couple. If we discard the marvelous side of these stories, there remain facts that may be regarded as historical.

The King of Crung-Kampuchea, aided by his numerous companions of emigration, made laborers out of the aborigines. The foundations of his fortress, palaces and temples may have been begun upon the fertile land that the sea left bare in gradually receding in this part of the territory, as is now demonstrated. The Cambodians agree in saying that the extensive ruins known under the name of Angkor-Thom are precisely those of the ancient structures undertaken by King Prea-Thong and his successors, or, according to the legend, those that the King of the Dragons caused to rise from the earth. The end of the dynasty of Prea-Thong was marked by baleful events. In the year 125 B. C., the Khmer people suffered an invasion of the Chinese, and, in the year 43, another one by the King of the Khams. It is permissible to presume that the citadel of Angkor-Thom and its principal edifices, constructed during the long interval of peace that occurred in the first period of the dynasty of Prea-Thong, were finished previous to these disturbed epochs.

The fortified town or the Pon-Teay of Angkor-Thom measures nearly seven miles in circumference. Its walls, 20 feet in height, are surrounded by a ditch 395 feet in width and 13 in depth. We give the aspect of the entrance gate that affords access to the ancient fortress of the south side (Fig. 1). Despite the ruinous state in which we find it, we distinguish the dome that surmounted it. It represents the head of Brahma, whose four faces are directed toward the four cardinal points. These heads bear a tiara representing towers. Lower down we observe a sort of frieze composed of divine personages in the attitude of prayer. Represented only as far as to the middle of the body, they seem to start from the center of a lotus flower. Among the ruined portions we still see the remains of the motifs that accompanied the lower sides of this majestic entrance in so original a manner. It is a huge tri-

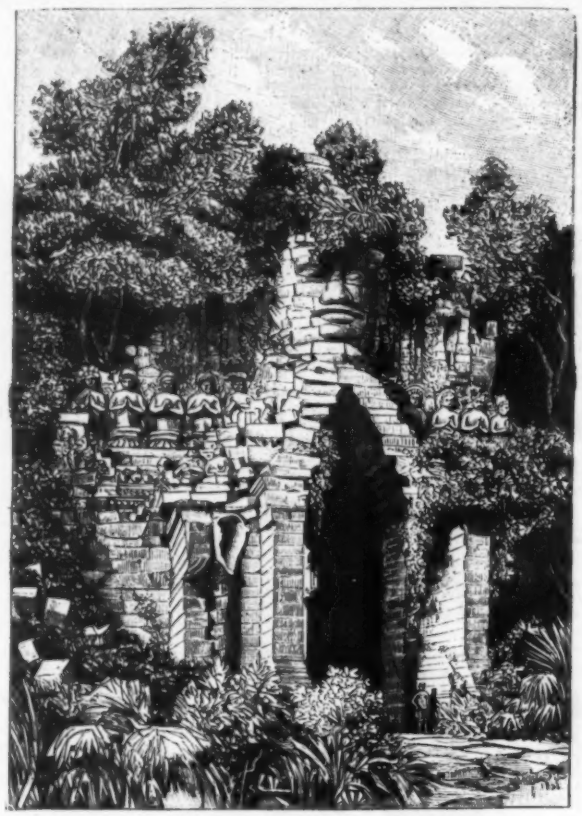


FIG. 1.—ENTRANCE GATE (SOUTH SIDE) OF THE FORTRESS OF ANGKOR-THOM.

cephalous elephant, Airawaddi, the favorite elephant of Siva, of which we observe the heads, upon which are seen the broken remains of three divinities that seem to be driving him.

A Chinese officer who traveled in Cambodia in the thirteenth century, wrote a narrative with the title: Tchin-la-foung-Thou-Ki (Description of Cambodia). In the translation of this by Mr. Abel Remusat, we read with curiosity a description of the entrance of the citadel of Angkor-Thom, which, at that epoch, was still intact. The following is an extract from it: "The capital is 20 lis in circumference and has five gates. Beyond the gates there is a great ditch, and beyond the latter there are avenues of communication with large bridges. On each side there are 54 statues representing divinities. The arches are figured in the form of serpents, each of which has nine heads, and passers-by are forbidden to approach them. Each of the fifty-four statues holds a serpent in the hand. On each side of the gate there are figures of elephants carved in the stone." At present, the ruins of a few statues that ornamented the bridges, the walls and the figures of elephants are proofs of the sincerity of the Chinese officer's narrative.

Of the ancient city of Angkor-Thom, whose houses were constructed of wood with thatched roofs, there no longer remains any trace. The site of the palace of the kings is still visible under the vegetation. We discover the vestiges of the ancient terraces, stone roadways and much rubbish. Along with the walls and their triumphal gates, a few important structures still remain, but in a ruined state. These may be thus enumerated: The edifices of Pimeanacas and Bapuon, both formed of superposed terraces, do not seem to possess a religious character; the high walls covered with bass-reliefs upon which we see the celebrated statue of the leprous king; a few remains of palaces; and the terraces called Dam-reys (elephants). Fig. 2 shows a part of their remarkable sculptures. These are the bass-reliefs of the south side. Elephants of less than natural size formed the angles of this terrace, which was finished by a flight of stone steps. It led to Bapuon. Banh-Yong, the most interesting structure of the entire country, and which exceeds in originality anything else that the Khmers were able to create, finishes the nomenclature of the most curious ruins in Angkor-Thom.

The edifice of Banh-Yong was not solely religious, for the Khmers considered it also as a place of promenade and pleasure. The entire work nevertheless was dedicated to Brahma, as everything indicates in the least parts of the structures. The ruins occupy a wide area. The facades of its second wall are more than 460 by 490 feet in extent. Those of the base of the sanctuary are 250 by 280 feet. They offer to the eye splendid perspectives. The interior walls of these porticoes are occupied by a series of bass-reliefs. The crumbled remains of the arches unfortunately conceal a large part of them. It is to these places that the inhabitants of Angkor-Thom came to meditate and pass

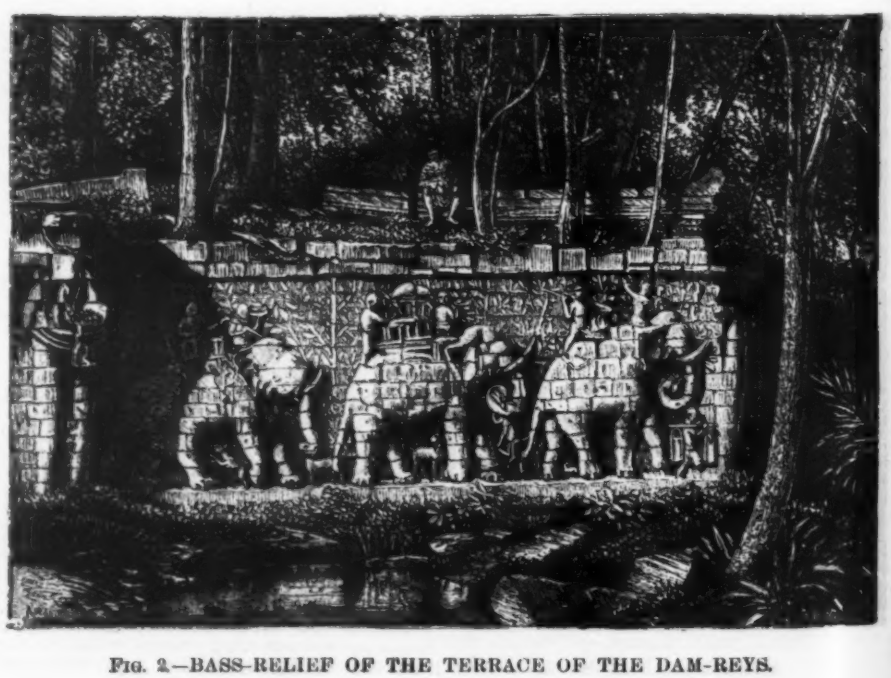


FIG. 2.—BASS-RELIEF OF THE TERRACE OF THE DAM-REYS.

away their spare time. They had a pleasing view of the gardens, and, turning their eyes to the walls, they could contemplate the sculptures representing the familiar scenes of their existence, such as hunting, fishing, contests or dancing, and then the marvelous deeds of the heroes and gods described in the Hindoo poem Mahabharata. Despite the forest that has been ruining it for many ages, Banh-Yong still possesses almost all its domes, terraces and interior courts bordered with galleries. The crumbled arches and colonnades do not prevent the traveler from exploring the greater

FIG. 3.—DOMES WITH THE FOUR FACES OF BRAHMA, SEEN FROM THE UPPER TERRACE OF BANH-YONG.

part of the edifice, and it is possible for him to get a view of it as a whole.

A low wall served as a first inclosure, and embraced two vast ponds situated in a park in which were doubtless situated the houses of the guardians of the sanctuary. A second and rectangular wall, with large entrance vestibules connected by porticoes, came next. Placed upon a high terrace ornamented with balustrades and monumental stairways, it formed the first story of Banh-Yong. Internally, this second inclosing wall, whose sides destitute of ornament contrasted strangely with the richness of the central structures, contained a magnificent garden. Sixteen domes, composed of four heads of Brahma, connected by elegant porticoes, erected upon a high sub-basement, constitute, along with four small courts accompanied with galleries and sanctuaries, the first bases of the great Prea-sat placed upon the upper terrace. In this group of structures, the four corner domes are alone upon the same level. The others rise gradually, along with their porticoes and sub-basements, to form a half story leading to the third terrace. These domes and their galleries, as well as their interior courts, being at different levels, communicate with each other through stairways or a few steps only. This singular arrangement renders, at first sight, the comprehension of the plan difficult and justifies the surname of the "hide and seek temple" that the natives have sometimes bestowed upon Banh-Yong.

The upper terrace is occupied by the sanctuary dedicated to the supreme god. This Prea-sat is accompanied with magnificent vestibules that indicate its principal entrance directed toward the east. Upon the other sides, light porticoes connect it with secondary sanctuaries that lead to stairways descending to the lower galleries. Under the Prea-sat was the mysterious hall into which daylight could not penetrate. The Brahmanic laws forbade the entrance of the faithful into it, for it contained the image of the god. The top of the Prea-sat is formed of a dome that rises to more than 130 feet above the surface of the terrace. It consists of four colossal figures of Brahma, whose forehead is surrounded with a tiara loaded with jewels and surmounted by a lotus flower. At this height, they dominate the other figures of the fifty domes grouped around them and rising by stages at their foot. To the traveler, the spectacle is one of the most unique in the world, when he contemplates all these divine heads with an expression serene and full of dignity. Their eyes, wide open, seem to follow one as he walks over this strange platform, a worthy abode for the supreme god of the Hindoos. In Fig. 3 we give the aspect of a portion of these domes with supernatural faces.

Outside of the wall of the fortress of Angkor-Thom there exist upon the territory of Siamese Cambodia numerous ruins that occupy a wide superficies. They are those of Prea-Khan, of Ta-prom, of the monastery of Kdey, and Angkor-Vat, the marvel that still remains almost intact. The kingdom of Cambodia possesses the magnificent remains of Beng-Mealea, of Preakane, (Kompong-Soai), etc. All these admirable ruins are less ancient than those of which we have just spoken. According to the Khmer annals and other ancient documents that have been preserved, they date from the first centuries after Christ.—A. Tissandier, in La Nature.

THE PARTITION OF AFRICA.

THE British sphere on the east of the African continent, shaded with dots in the accompanying map, has been recognized by Germany, Italy, and the Congo State. The northern part is conterminous with the eastern frontier of the French Congo colony, and it is here that an invasion is feared, as the French have not recognized, or taken any official note of, the British claims. Lord Kimberley attempted last year to safeguard the British sphere by handing this portion of it over to the Congo Free State on lease, but owing to the protests of France and Germany that portion of the treaty was abandoned. In a subsequent treaty between France and the Congo State, it was agreed that the latter should retain only a small portion of the leasehold offered by Lord Kimberley—such portion including the station of Lado on the Nile—but in view of the breakdown of the treaty with Great Britain, and the fact that the Franco-Congolese treaty has not been recognized by the British government, it is doubtful whether this leasehold will be allowed to stand.

With regard to the Niger, the trouble between Great Britain and France arises out of the trespasses of French expeditions which recently visited Bousa and Nupe. The idea of these expeditions seems to have been that the claims of the Niger Company to dominion in those places were not sanctioned by treaties with the local chiefs. By this time no doubt they have discovered their mistake, but neither apology nor explanation has yet been forthcoming from the Quai d'Orsay.—Daily Graphic.

1. Anglo French Agreement, August, 1893 2. Anglo-German Agreement, July, 1890. 3. Anglo-German Agreement, November, 1893. 4. Anglo-Italian Agreement, March and April, 1891. 5. Anglo-German Agreement, October, 1886, and July, 1893.

AFRICA: MAP SHOWING THE SPHERES OF INFLUENCE OF THE EUROPEAN POWERS.

SATURN'S RING.

IF Prof. Keeler, of Pittsburg, has positively demonstrated and established the fact that the ring of Saturn is composed of innumerable small satellites, he has achieved a notable feat in astronomical discovery. The theory that the ring is so composed is not new entirely, but it has never been fully verified. Prof. Keeler's process of reasoning is not only scientific, but exceedingly ingenious, and it seems that he has solved an astronomical problem of long standing.

The ring of Saturn is itself one of the strangest mysteries of astronomy. Why Saturn alone of all the planets of the solar system should have a ring is incomprehensible. Jupiter, which is more than three times as large as Saturn, has no ring, and all the smaller planets get along without one, Saturn alone being supplied with the exceptional and apparently useless appendage. The ring consists of three apparent rings lying in one plane and of different degrees of density. The inner edge of the ring is about 5,900 miles from the planet itself, and its total diameter is 172,800 miles.

It was first discovered in 1659, and has been more or less a subject of speculation and observation by astronomers ever since. It was at first assumed to be solid, but that theory was abandoned. Then the accepted theory for a long time was that it consisted of a vast number of particles or minute bodies free to move relatively to one another; in short, that it was fluid. The theory was largely conjectural.

For about twenty-five years past the ring of Saturn has been a subject of continual vigilance and study by astronomers. Searching telescopes in all parts of the world have been pointed at it at regular and frequent intervals, and there have been few nights in the year when sharp and learned eyes have not been trying to unravel its mystery. In 1870 M. Trouvelot, a French astronomer of note at that time in this country, but who afterward returned to France, began a series of observations of Saturn, first with his own telescope at Cambridge, Mass., and later with the much larger ones at Harvard University and the observatory at Washington. In 1876 he announced some interesting conclusions, but none touching the composition of the ring, except that "the matter composing the dusky ring," meaning the part nearest the planet itself, "is agglomerated here and there into small masses which almost wholly prevents the light of the planet from reaching the eye of the observer."

From 1875 to 1877 Crofthall, of Washington, made a series of observations which led to no definite conclusion beyond confirming Mr. Trouvelot's description of the appearance of the dusky part of the ring as "somewhat like particles of dust floating in a ring of light traversing a dark chamber."

In 1881 Dr. Meyer, a Swiss astronomer, made a series of observations which led to a careful revision of the figures relative to the dimensions of Saturn and the diameter of the ring. Prof. Kirkwood, of this State, had, as early as 1868, demonstrated that the division in the ring or the space between its inner and outer parts was due to the disturbing influence of Jupiter,

and this led Dr. Meyer and others to the conclusion that the ring was formed of separate particles moving round the planet to a certain extent as independent satellites. Owing to the peculiar position of the ring from 1884 to 1886 inclusive, the winters of those years were more favorable for studying Saturn and its ring than any which will occur again till 1914. During these years the great refractor at the Washington Observatory was frequently pointed at the Saturnian system, but no material addition was made to the stock of knowledge on the subject.

Observations of an eclipse of one of Saturn's satellites in 1889, made at the Lick Observatory, California, showed that the ring cast as dense a shadow as that of the planet itself, and this was thought to disprove the theory that the ring is made up of a vast number of satellites, since no matter how great the number, it was thought they could not have the effect of an opaque body.

From this brief outline of Saturnian observations during the last twenty-five or thirty years, an outline which conveys no adequate idea of the patient research, profound study and immense learning which have been brought to bear on the subject, it will be seen that not much advance has been made in determining the character and composition of the ring. Astronomers can estimate its mass, determine its distance from the planet, measure its diameter and calculate its mathematical elements, but what it is composed of or what purpose, if any, it serves in the economy of the universe, they have not been able to discover. The most powerful telescopes have revealed more clearly the proportions and outlines of the ring, but its composition has remained an insoluble mystery. If Prof. Keeler has succeeded in solving it and can demonstrate the correctness of his solution, he will have earned undying fame in the astronomical world. Saturn already has twice as many moons as any other planet in the solar system, namely, eight, while our earth has only one, and Jupiter, which is a far larger planet than Saturn, only four. If the ring is really composed of moons, Saturn could afford to spare a few for the other planets.—Indianapolis Journal.

CONTRIBUTIONS TO SCIENCE BY INSTRUCTORS.

By MARCUS BENJAMIN, Ph.D. (Columbia).

THERE is a prevalent belief that college professors are for the most part mere theorists or doctrinaires, and that no results beyond their mere function of teaching is ever accomplished by them. I must confess to some astonishment myself in thinking over the subject to be able to recall so many practical discoveries that have come directly from the study or laboratory of the college professor. This has been particularly the case in the domain of science. The recent death of the great Helmholtz, who was hailed as the first of living scientists when he was made president of the Congress of Electricity in Chicago, during the recent World's Fair there, brings to mind his valuable discovery of the ophthalmoscope. This instrument he invented in 1851, while filling the chair of physiology in the University of Konigsberg. It is described by competent authority as "an instrument by means of which the retina of the living eye can be inspected, and which has completely revolutionized the knowledge of its condition in health and disease, and has saved thousands of persons from blindness." It was in Heidelberg—that beautiful university town overlooking the Rhine—that Bunsen and Kirchhoff conducted those magnificent researches out of which has grown the science of spectrum analysis. By means of the spectroscope, which they perfected in 1860, we have learned the constitution of the heavenly bodies and their motions directly toward or away from the observer. The atmosphere of a star, comet or nebula yields its composition to the analyst, who can also approximately determine the temperature and pressure of the glowing gas. The chemical elements cesium, indium, thallium, gallium and scandium have been discovered by its aid. Joseph Henry was a professor in the Albany Academy when he perfected what is now called the electric telegraph. "The thing was perfect as it came from its author, and has never been improved from that day to this as a sounding telegraph," is the statement from one writer; while another electrician has said, "The essential features of the telegraph of to-day consist solely of the work of Joseph Henry and Alfred Vail."

Synthetical chemistry has proved a rich field for the workers in university laboratories. From the time of the synthesis of urea in 1828 by Wohler, who was then a teacher in Berlin, through the wondrous maze of the brilliant coal tar colors, among which may be mentioned conspicuously the superb red of the alizarin or artificial madder discovered in 1868 by Graebe and Liebermann—both at that time instructors in educational institutions, Graebe in Geneva and Liebermann in Berlin—and the more recent artificial indigo by Baeyer, in the University of Munich—down to the discovery of saccharin, which is 500 times sweeter than sugar—in the laboratory of the Johns Hopkins University, the progress has been persistent, and the value of the benefits conferred upon humanity simply enormous. Words are inadequate, and statistics are bewildering to the mind, so that the simple statement of the fact must suffice.

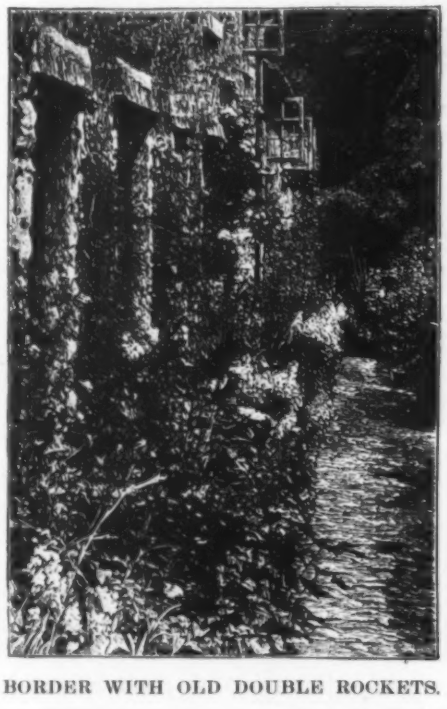
Only two branches of science have been referred to—physics and chemistry, and both superficially. Alexander Graham Bell, to whom we are indebted for the telephone, was a teacher, and Elihu Thomson, who invented electric welding, was also a teacher, and left his classroom in Philadelphia to go and take charge of a large plant. What would a glance at other sciences disclose? Think of the rich researches in philology by Whitney, of Yale, and March, of Lafayette; and of the splendid discoveries in paleontology by Marsh, of Yale, and Cope, of the University of Pennsylvania. The studies of the soils and of fertilizers by such men as E. W. Hilgard, of the University of California, and Charles U. Shepard, of the University of South Carolina, must not be forgotten. Nor should we omit to record the able work on the mines of our Pacific coast by Prof. W. B. Rising, of Berkeley. Botanists, entomologists and other naturalists connected with our educational institutions have surely done their share, too, and have done it well.

But an end to this. I have shown some things that, at least, in modern times, have come from our college professors, and things that are of practical value, and I have suggested others.

It is beginning to dawn upon one that these college professors are not such a bad lot as any undergraduate fancy pretends them to be, and whisper it softly, I have taught myself. Perhaps I have made a discovery, and I know of no better way of making it known than by taking the readers of the University Magazine into my confidence.

ROCKETS.

THE accompanying illustration is a pretty reminder that the sweet old rocket, a flower most of us have known from our earliest days, still has its admirers, although it is all too scarce in gardens generally. The time when rockets bloom is a lovely one, for the early summer flowers are gay in great variety. Then especially are the simple roadside cottage plots so bright and sweet, when rockets spring out from carpets of pinks and pansies and lift up their tall spikes to meet the drooping clusters of the monthly or maiden's blush rose. Happily this flower is much loved by cottagers and it will linger long among them, but in larger gardens we seek it in vain—it is neglected. This neglect arises not from lack of appreciation of its beauty and fragrance, but because, although in every respect a hardy plant, it does not go on growing and flowering year after year. It wants a little special attention, and this to be given at the right time. If left to grow and extend as most hardy things do, it resents such treatment and soon disappears. It should not be included among the true perennials, as it cannot be treated like them, and yet there are many pretty ways in which it could be grown. The essential thing is to always have young plants. Although occasionally a group may stand a second season, the safe way is to always have a batch of young plants. These may be raised from cuttings, which root readily even in the open ground if shaded from bright sun, while



BORDER WITH OLD DOUBLE ROCKETS.

another excellent method of keeping up a stock is to take up and divide the plants as soon as they have ceased to bloom, replanting them in another spot. In a well managed garden there should be a reserve plot where stocks of this and kindred flowers requiring similar treatment might be raised. With such an aid much could be done to reduce the number of tender plants still put out in gardens and show the best flowers of each season in the most perfect way. There are several distinct forms of the double rocket, varying in color from pure white to lilac, all of them pretty, sweetly scented and worthy of the best care and culture.—The Garden.

MOLASSES USED AS CATTLE FOOD.

A CORRESPONDENT of the Deutsche Zuckerindustrie gives a description of the manner in which molasses is being used as cattle food in Germany, which may prove useful to some of our readers. At the present moment the question of the use to which molasses can be put is one of considerable importance in Germany, inasmuch as the export of this product to France, which formerly went to that country in considerable quantities, is now stopped, owing to the heavy duty lately imposed there. The writer in question had been paying a visit in the neighborhood of Roitsch (Prussian Saxony), and availed himself of the chance of obtaining information as to the mode and extent of the use of molasses as cattle food. He says:

My friend had asked a farmer to delay the feeding of his cows until we could be present. Molasses is served out to them at midday and in the evening, in the following way: After they have eaten about three-fourths of the dry fodder, the molasses (mixed with broth) is poured over the remainder. It was a sight to see, when the maids came with buckets containing the broth, how expectantly and greedily the animals looked for it, and could hardly wait till it was poured over the fodder. When this was done, you should have seen and heard the eager consumption of the whole; any cow keeper would have been delighted with it.

We afterward inspected the mangers. They were cleaned out and licked perfectly clean—a proof that the animals appreciated this kind of feed.

Milk cows, cows in calf and oxen get daily three pounds of molasses per head. It is simply dissolved in their liquid food. The farmer takes the molasses just as it comes from the factory and pours it into the stone trough in the feeding shed. This method of using involves no trouble of preparation or new apparatus. In my opinion, it is the simplest and best way of utilizing molasses.

The farmer whose establishment we visited has already been using this system of feeding for some months. It has not had the slightest ill effect on his stock, and he will adhere to it for the future. A further visit to a neighboring estate, where there were eighty cows in the sheds and over 100 oxen, led to the same experience. On this farm the molasses had been used continuously as above described for a period of two years.

In commencing to use the molasses, from one to one and a half pounds per head is given at first, and after about a fortnight the quantity is gradually increased to three pounds.

If the employment of molasses in this way could be steadily extended, it would be a great boon to the sugar industry. I am not disposed to favor the establishment of new factories for extracting sugar from molasses, for I really think we have got sugar enough. —The Sugar Cane.

[FROM THE NINETEENTH CENTURY.]

PENALTIES OF IGNORANCE.

ABOUT the year 1770 Madam Necker, describing a visit to a hospital in Paris when the capital prided itself on its civilization and luxury, wrote: "Patients who were recovering would have to share their beds with those who were dangerously ill, the poorly or the dying, a patient with an infectious disease or another merely temporarily indisposed. The most frightful scenes and fatal results were the daily consequences of this state of things in the dreadful refuges provided for earthly sufferings. The human race was sacrificed under the very eyes of doctors and nurses."

Exactly a hundred years later, and shortly before the outbreak of the Franco-Prussian war, I was taken by some friends to visit an ancient abbey in another part of France which combined a convent for Benedictine nuns with a general hospital for the sick. At the period of my visit antiseptic surgery was in its infancy, and the life history of disease was only beginning to be understood. That disease was found to have a life history at all was chiefly due to the researches of Pasteur, who had recently succeeded in proving the vitality of ferments. On the publication of his book on the ferments of beer and wine, Sir Joseph Lister, at once grasping the principle, never rested until he had applied the knowledge to surgical practice. Still, the result of the researches involved had, at the time of my visit, scarcely emerged from the laboratory and the bondage of early opposition.

The management of all hospitals was consequently in a state of primal simplicity when I passed through the wards of the abbey, which had been open to the sick for 800 years.

After the trim look and efficient nursing of those English hospitals to which I had been accustomed, I was greatly struck on entering the wards to find our advent excited a general commotion, one half of the patients darting back to bed, who had been attending to the wants of the other half, too ill to rise.

This scuttling about revealed a condition of things better not described, and was explained by the absence of the nuns, who were occupied with their devotions in the chapel down below. But even in these recent times cleanliness of the person and entourage was so little considered that a visit to the wards was not only a pain, but a danger. On reaching the children's ward I could only look at the crowd of creatures from the door, being unable to cross the threshold for the stench and reeking atmosphere within.

This, then, was the condition of things when the war broke out, and the wounded were carried in hundreds from the comparative safety of the battle field to this sanctuary of death. Friends writing at the time reported that "fever had broken out, and few left the hospital alive." Treated in ignorance, nursed in ignorance, they died amid continual but unavailing prayer.

No one was troubled with the thought that many of those precious lives might have been saved, for no one knew, or even suspected, that these sacred walls had been the breeding ground of living disease for eight centuries of time, and that death in most cases was the natural result of a violation of natural laws.

Not long ago I had an opportunity of visiting this hospital again, and found that the epoch had made its mark. At first I had misgivings as to what I should find, for, passing through the lofty cathedral, I heard the same old wail of the nuns at prayer, and peeping through the grille saw a number of them rapt in meditation. But in the wards all was changed; knowledge had taken the place of ignorance. Throughout the corridors a whirlwind of air swept day and night, bathrooms were established, the wards were untainted; silence, order, and cleanliness—scientific cleanliness—prevailed. Throughout the wards a sufficient number of "sisters"—no longer the gloomy, heavily clad nuns—were in attendance, and they, in common with the doctors and assistants, were clothed in modern overalls of white. The pestilential children's ward no longer existed, the children being dispersed among the adults.

There was no need to ask questions where everything told the tale of a new era begun. It was one more evidence of the immense reform which had sprung from Pasteur's studies on ferments, studies which link the brewery with the hospital, the chemist with the physician and surgeon in one united chain.

Not only, however, in France is the modernized hospital to be found, but in Germany, Denmark, Finland, and Russia, examples of old hospitals may be met with admirably brought up to date, with a relative decrease both in mortality and morbidity. The largest and most perfect hospital existing is the Johns Hopkins, in Baltimore, which was built on modern scientific principles from basement to roof about seven years ago.

Without entering too deeply into the well-known controversy which focused the attention of Liebig,

Pasteur, and others on the brewer's vat, it is sufficient to state that it lay with Pasteur to prove experimentally, and determine for ever, that yeast was a living plant which produced itself by budding. Further, that the diseases which affected beer were caused by the presence of other living plants, all belonging to the lowest form of fungoid life and world of invisible organisms.

To find the analogy between the working of the yeast and the working of zymotic disease in the human subject, it will be necessary to give a moment's attention to the life history of the little yeast cell as it performs the chemical operation of transforming the wort into beer, an operation beyond the power of any human chemist or any human brewer to perform. From a previous brew the brewer takes a little yeast, adds it to the wort which he has prepared, and leaves it alone. At first all appears to be quiet, for this is the period of incubation, which means an immense deal of quiet energy before a sign of fermentation can be seen.

At this stage our little yeast cells are renewing their youth and reproducing themselves under the influence of the free oxygen and organized substances they find there; but gradually, as they absorb from the mass that which they specially require for their subsistence, certain elements are set free which entirely alter the original conditions of their life.

As carbonic acid gas is one of these elements, it is evident that free oxygen can no longer be within reach of our little cells, but, making the best of circumstances, they still contrive to wrest from the sugar of the barley just sufficient oxygen to enable them to become acclimatized to the altered environment. At this point the multiplication of the yeast cells becomes slower, while the splitting up, or rather breaking down, of the elements goes on faster, fermentation is visibly at work, and the final product of our little cells is the pure alcoholic beverage known to us as beer.

If a second supply of yeast were now added to the already fermented liquor, it would only cloud it, but have no more effect than a second inoculation of infectious disease—say scarlet fever—would have on a person just recovered. That element on which it formerly existed is gone, therefore fresh sown seeds would only remain inert or perish.

With regard to the diseases of beer, it was demonstrated in the course of these researches that the air everywhere about us is filled with the living germs of moulds, ferments, and bacteria, which cling to surrounding walls, and are wafted about by the wind. Carried on particles of dust, they are ready to germinate or reproduce themselves anywhere on finding a suitable soil. Since these early days methods have been found by which the different species can be isolated, cultivated, and studied separately.

Previous to these discoveries the brewing of beer was conducted under all the disadvantages of ignorance—ignorance as to the nature of the yeast and ignorance as to the nature of the diseases which affected beer. As a natural result, the brewer was tempted to sell it for consumption before it was properly fermented. Further, it was thought that any hole or corner was good enough for the brewing of beer, and no consideration whatever was given to site or cleanliness. Hence, in common with the hospitals of the period, the walls were the culture ground of disease, and, in common with the surgeons of the period, the brewers knew not whence the mischief came. The consequence was loss of human life on the one hand and loss of good beer on the other, until the remedies were found.

These remedies were arrived at simultaneously by the late Herr Jacobsen, an enlightened brewer of Copenhagen, who neutralized the dangers of surroundings by keeping the air too cold for the vitality of the putrefactive organisms, and by Professor (now Sir Joseph) Lister, who introduced the present system of antiseptics. By the latter process the danger of blood poisoning is averted by sterilizing in certain acids all the instruments used in a surgical operation, and by sealing the open wound against the entrance of disease organisms by the use of carbolized dressings.

While recognizing the enormous advantages which have accrued to mankind by the application of these scientific principles to surgery and brewing, let us now consider how far we have got in applying the same principles to the everyday things of home life.

Since Pasteur in the course of his chemical researches dragged the long-hidden cause of disease into light, and opened our eyes to a hitherto unsuspected law of Nature, we can no more get rid of the newly revealed facts than we can stop the rotation of the earth. And yet this knowledge, so important in housekeeping, so useful to those who are responsible for the health of others, and which so closely concerns us all, forms no part in the general education of the people. The precious key has been given to us, but, so far as domestic life is concerned, the gates of knowledge remain closed. Now, if the poor man understood the raison d'etre of the antiseptic dressing of his wounds and the rich man knew the beautiful part Nature takes in providing him with the clear and sparkling ale and wine* on his table, then would they severally learn that the matter of life or death, success or failure in many things, depends on our realization of that world of busy living organisms which we cannot see. But as things are at present, we accept our blessings, as we accept our pains and penalties, in profound ignorance of why and whence they come; and until we fully recognize this "third realm," and understand its direct and indirect influence on our health and the healthiness of the perishable things round about us, we are bound to suffer the consequences of ignorance and waste.

Not long ago I had a striking instance of the domestic penalties attending ignorance of these natural laws which every woman ought to know. During a visit to a country house my hostess complained that life was an endless struggle with housekeeping, and that she "felt always walking in the dark, perfectly unable to anticipate what would go wrong next." The meat would not hang till it was tender without going bad, the jam went mouldy, the apples went rotten when stored, and the milk went sour. Such misfortunes were the troubles of daily life, and were accepted as simply inevitable.

The house was a fine old English mansion which had served as a family dwelling place for over two hundred years. The drains and the water supply had been brought up to date, but the larder was the same as at the beginning.

This was a long narrow room receiving warmth from the adjoining kitchen and damp from the ground below. A small window at the far end covered with perforated zinc was the only means of affording light and ventilation, but as it opened into a walled court, no moving air could penetrate the damp and dim recesses where the meat was kept. The whole place was scrubbed out once a week, but never seemed to do any good! Now, in circumstances such as these wet cleaning could only add to the mischief, but from want of a little scientific knowledge the trouble went on the same in the nineteenth century as in the seventeenth. In the middle of the place hung an ordinary meat safe, but, strange to say, "the meat would not keep even there!"

On visiting this larder I was deeply interested to find myself in the midst of surroundings which had become more or less familiar to me in visiting various microbiological laboratories in different parts of the world. Whatever it might be to the mistress of the house, it was certainly to me most fascinating to discover Dame Nature at her work fulfilling her role undisturbed in this most disapproved fashion. Here in the homely larder Nature was having her way unhindered by the scientific mind which in the laboratory keeps all things under control. Some sausages which had been placed on the shelf the night before were the first interesting objects that met my eye, for they were beginning to develop a most beautiful growth of the micrococcus prodigiosus, the same fungus which is accountable for the miracle of the bleeding host. I found it also exuding like drops of blood on some cheese not far off. This is a microbe which has done more than any other to terrify the ignorant and credulous, as it develops rapidly, and breaks out in unexpected places, not only on bread, cheese, and meat, but on ponds and reservoirs, and when drawn into the air may be discharged again in the form of rain, giving rise to the phenomenon we hear of when it is said to rain blood.*

But this was only one species of organism in the midst of many less demonstrative, though equally active in the work of destruction. Everywhere the early signs of putrefaction had begun, leading to the waste complained of. I was able to explain to my friend on the spot that, although the shelves and floor looked so scrupulously clean, the walls, the wire gauzes, the nooks, crannies, and corners, were laden with the spores of many moulds and with bacteria, the invisible agents of putrefaction and disease. In her larder every condition was present that favored their vitality and reproduction. This larder was simply a culture ground for disease germs, and was in fact in the same condition that our hospitals were in before Sir Joseph Lister introduced antiseptics. In the larder, food was the article provided for the nourishment of living but invisible organisms, while in the hospital it was human flesh and blood.

Something might have been done by placing charcoal over the shelves and floor to absorb the moisture and purify the air, but, as the place was radically bad, we agreed to condemn it forthwith in favor of temporary quarters until thoroughly sanitary larders could be established, which, by excluding the conditions which favor putrefaction, were really suitable for the preservation of cooked and uncooked meats respectively.

We now passed on to the apple loft, to discover, if possible, why the apples would not keep, although they were stored over the laundry! It happened that I had been visiting a friend not long before in an ancient chateau near Arbois, and she had taken me to see her apples stored in a cellar under the ground floor of the castle. These cellars or vaults were of vast extent, and were chiefly devoted to the making of wine from her own vineyards. Throughout, the air was pure, still, cold and dry—in fact, all that scientific knowledge could make these cellars—for my hostess was an ardent disciple of Pasteur, who for years lived in the neighborhood, and had conducted some of his most interesting experiments on ferments on the Jura mountains close by. As I was leaving the chateau that day I was presented with one of the beautiful apples to eat on the journey. It was cool, firm, and as fresh as the day it was gathered exactly a year ago. When I reached Paris I placed the apple in a cupboard in my bedroom, where it soon began to shrivel and decay. The change from a temperature and conditions inimical to fungoid life, to an atmosphere warm and damp, and teeming with the invisible spores of innumerable organisms, soon proved fatal to the apple.

The remedy which naturally suggested itself in the present case was to store future apples—not the infected apples—in a cold cellar free from moulds.

A few years ago I went through similar experiences to those above recorded, in a country house I had taken in Scotland for the season. On paying my morning visit to the larder I found that all the meats cooked only the day before were moist and mildewy next day. As this was the only larder of the establishment, every kind of food was kept in it, as in the other case. Being large and well lighted, it looked to the uninitiated all that the larder of a well appointed house ought to look. The reason of its disastrous influence on the family food was not far to seek, for, besides being damp, it rejoiced in the close proximity of a dust heap, into which every kind of putrescible matter was thrown. This foul spot was not hastily removed in the height of summer, but was there and then covered over with dry garden soil, which rendered it innocuous, and a new larder was erected outside, where the pure air could circulate all round it.

It is curious in these days of sanitary science to find so little attention given to the larder as a factor in health, when its importance should at least be recognized pari passu with the drains. As a rule, there is only too close a connection between the two which it would be advisable to cut off.

In order to realize the dangers to health which may arise from neglect of our larders, we cannot do better than give some consideration to the local government reports on food poisoning. Therein may be found every detail from the deadly feast to the subsequent inquiry. The repetition of cases is truly bewildering. There is the "Wholesale Poisoning of a Family;" "Poisoning of a Wedding Party;" the sausage case; the brawn case; the pork pie case; poisoning by sardines, tinned meats, etc. In these cases the poison has not been placed in the food by any murderous human hand; but, manufactured in the damp and dim recesses of the cellar or larder, or in badly closed tins, it finds its own way to the food with all the subtlety of an invisible agent, acting in simple obedience to a natural law. To take one of the many cases. A family who had hot leg of pork for dinner on Sunday were well on the following day. On that Monday one or two members of the family ate the cold pork for dinner again, and were attacked with illness from seven to nineteen hours later. Now, in the evening of the same day, two other persons partook of the pork and developed symptoms of poisoning after an interval of only four hours. The poison at the end of the day had become more intense as the day wore on, consequently the supper proved fatal, and those two persons died. The history of the pig was traced, and it was proved that the animal was healthy, and that no one else had suffered from eating the other parts of the same pig. On the other hand, the cellar where the cold pork was kept was found to be unfit for the healthy preservation of meat, and it was observed that milk went quickly sour and would not keep in the cellar.

In the United States of America a few years ago a number of people were poisoned by eating frozen custard, and the subsequent investigation brought forth the following facts: "The milk supplied to a small village had never been questioned. It was in constant use by some fifty or more people, and no case of illness had arisen which could be in any manner attributed to the milk. In the preparation for a festival, some gallons of this milk were obtained and made into custard. The custard was divided into two portions, one of which was flavored with lemon, the other with vanilla. The lemon custard was eaten without harmful effect, while a teaspoonful of that flavored with vanilla caused nausea, vomiting, and purging. Of course it was quite natural to conclude that the vanilla was the poisonous agent, because at first it seemed that the only difference between the samples was that due to the use of the flavorings. Fortunately, however, not more than half of the vanilla in the bottle had been used, and the non-poisonous character of this flavoring was demonstrated by a young man who took two teaspoonfuls of the remainder without being in any way affected. The real difference between the portions of the custard is explained by the following: The lemon custard was frozen immediately and sent to the festival, while the vanilla custard stood for two hours before being frozen in a very filthy room, the air of which was said to have been like that of a privy vault. This room had been some weeks before used as a butcher's shop, and had never been cleansed, and the bits of decomposing meat rendered the air foul, and supplied the germs with which the custard was infected."**

Even without any unpleasant smell and flavor of decomposition to give warning, the products of microbes may be virulent. That is to say, a chemical change in the material has been effected by their presence. In cool and wholesome surroundings the multiplication of these organisms is retarded; hence the change from safety to danger is too slow for accidents to happen as a rule; but in damp, warm, and unwholesome surroundings the change is rapid, giving rise to mild or severe attacks of diarrhœa, followed in some cases by death. In all albuminoid substances undergoing decomposition these poisons are generated, and are now termed "ptomaines," from ptoma, a dead body.

Examples of these have been obtained from putrid mackerel and putrefying codfish, and one—taken from the same sources—is so highly poisonous that it has been compared to the venom of the cobra.

Another highly poisonous substance has been isolated from putrid gelatine and sweetbread, and another from putrid cheese. It is not the microbe itself that is poisonous, but its "product"—that which it produces—that kills human beings when swallowed.

Apart from the danger of illness, there are few houses where the housekeeper does not suffer from perishable things perishing. We have only to walk along the fashionable thoroughfares of our metropolis in summer to become painfully sensible of the fact that sundry joints of meat and "special fed" poultry are about to appear on fashionable tables from a tainted source. It is not an uncommon thing to find a milkshop in the midst of a mews surrounded with steaming dungheaps. Often the milkshop has to do duty as a post office, where people are continually going to and fro, and sometimes it forms part of a general store, where things are sold not altogether savory. Poulterers' shops are apt to be the worst, for there live rabbits are kept on the premises awaiting the hour of their doom. And not long ago a friend going to buy a Christmas turkey found, in addition to rabbits and other live creatures in hutches, two large bulldogs, one gnawing the head of a turkey which was dangling conveniently over its kennel. The natural result of such a shocking state of things is that expensive poultry reaches the table tainted, and tasting, as some one said, of the smell of the shop. In the first place, the shop is in a street, and the street is overlaid with dung and other impurities, and then watered to lay the dust. Nothing could be better for the putrefactive organisms, or worse for the meat, for the heat from above and moisture rising up from below complete the necessary conditions of their existence, and favor their rapid reproduction in the food.

Now there is no reason why we should accept any provisions that are going through this putrefactive process, for the same principles which have already done so much to save human life in hospitals, and to save many important industries that suffered from deterioration and disease in various forms, may equally well, and with equal advantage, be applied to every provision shop and every big and little home throughout the country.

In America a great deal of waste is saved by a widespread system of cold storage. An illustrated journal with a large circulation is devoted to this subject alone. One contributor describes his losses in butter till he adopted the cold storage system, which he recommends

---

* The ferment that causes the fermentation of wine is deposited by Nature on the outside of the grapes at the time of year they are beginning to ripen. If only the inside of the grapes were used apart from the husk, no fermentation would take place, no wine would be produced, and the must would fall a prey to the organisms of putrefaction.

* This is a very minute vegetable micro-organism; the individual cells are only visible by means of the microscope, and it is one of the most interesting of the color-forming bacteria.

* Dr. Victor Vaughan, Michigan.

being adopted in immediate connection with the farm, the object being a purely scientific one—namely, to save the butter from being exposed even for a few hours between the churn and the cold chamber. In this way it can reach the customer "after keeping six months or more, so that no expert can tell it from butter only a few days old."

Another writer describes the profits derived from storing fresh eggs in the same way for supplying the trade; but for ordinary domestic purposes eggs will keep fresh if protected from the air by simply being rubbed over with salt butter while new laid, and, if possible, while still warm.

It is regrettable to think that four millions sterling is paid away annually for the importation of eggs from other countries while our farmers, on the one hand, are deploring bad times, and the British public, on the other hand, and with very good reason, are continually deploring bad eggs. When we consider the over-abundance that comes in the spring and summer, and compare it with the scant supply of farm produce in the winter, the only reasonable plan seems to be to equalize the supply throughout the year by the adoption of those scientific measures which are quite within our reach.

While we are still regarding ice as a luxury only to be used on our table in the height of summer, the Americans have long since adopted it as a domestic necessity for the daily preservation of food. A few years ago, when visiting New York, I noticed that many high class houses had a mysterious little building at the back to which the various cooks were continually bringing different articles of food, or from which they were taking food away. These turned out to be cold storage places, which were daily supplied with ice. They were not the clumsy refrigerators to which we are accustomed, and which hold so little, but spacious, convenient cold cupboards.

Cold is one of the simplest and least objectionable antiseptics that can be used in the case of food, and must not be confused with freezing, which interferes more or less with the flavor of meat and game. In applying cold it is sufficient to preserve exactly the amount of chill that will suspend the vitality of the putrefactive organisms. Meat that is brought from New Zealand and Australia is frozen, owing to the distance it has to come, but meat brought from America is simply chilled. Great cold storage depots are now established at the docks for the reception of frozen and chilled meats pending arrangements with the dealers; otherwise all the advantages gained up to this point would be lost.

During the great congress on hygiene and demography which was held in London in 1891, many interesting papers were read on the communication of disease from animals to man, and the diseases which affect man from eating the diseased flesh of animals. As most of the leading authorities of the world were assembled to take part in the discussions, many curious facts were brought to light marking the age of transition in which we live.

The precautions taken to prevent diseased meat getting into the market were fully discussed. In Germany, apparently, the precautions taken are the most stringent and scientific, for in connection with the abattoirs, which are under strict supervision, certain portions of the carcass are subjected to microscopic examination before being "passed."

In America animals are examined before and after being killed; but in our own country the condition of things seems to be so unsatisfactory that one German professor expressed himself as surprised to find in England—"the cradle of hygiene"—that "meat inspection, one of the most important branches of public sanitation, had been so thoroughly neglected, notwithstanding fact that it might so easily be enforced."

It seems that, if an inspector seizes meat at the market which he suspects to be tuberculous, he is not empowered to condemn it forthwith, but has to take it before a magistrate to be condemned by him. If the magistrate refuses to condemn, the meat goes back to the market, and the owner is now at liberty to bring an action for damages against the inspector. Dr. Vacher, Medical Officer of Health at Birkenhead, who describes in his paper a frightful condition of things, says he has known within his own experience such actions brought successfully against the inspectors.

It is true that when infectious disease breaks out on a farm it has to be notified to the local sanitary officer, who may at once condemn the whole herd. Compensation may or may not be given, but there the matter ends. Knowing what is before him, the farmer's object in life is to conceal the outbreak of disease if possible, and to send his animals off on the first sign of sickness to the nearest butcher, where no questions are asked, and where no supervision exists.

There is no doubt that in most country places throughout England, Scotland, and Ireland the farm buildings are much in the same condition now as our hospitals were in a century ago, when disease and its causes were not understood. No attention is given to ventilation and cleanliness. When sickness breaks out the animals are either ruthlessly slaughtered or left to take their chance of recovery in conditions which favor disease more than health—death more than convalescence. On the very farm which supplies the market daily with milk and butter, sick and healthy animals may be herded together, sharing the same roof and attendants, no one knowing any better, or able to recognize the danger. The laws of health in the case of animals being exactly the same as with human beings, the farm in such circumstances is no better than the pest house in Paris so vividly described by Madam Necker.

When we consider the enormous benefits which have accrued to suffering humanity by reform in our hospitals, it is deplorable to think that our farms are left behind the age, mere culture grounds for the diseases of animals, and diseases that affect our milk, butter, and most things on which our daily food depends.

A few years ago, when visiting a friend in the Highlands, I had a fair opportunity of seeing the condition in which the average farm of the country was kept. My hostess one day was complaining of the "bad luck" she was having among the animals at the home farm; so I went with her on a tour of inspection, and found the byre (cowhouse) full of cows in every stage of dejection. Some had already died, and in a small byre adjoining the larger one we found the dying—a most miserable herd.

Nobody knew anything about the disease, but it was mentioned as a singular fact that the cattle left out in the field day and night were perfectly well.

This farm had been built about forty years ago, under all the disadvantages of universal ignorance of the most elementary laws of health. The byre was a long narrow building with a blank wall to the heads of the animals. Two windows, made not to open, were on the opposite side. The flooring was not of concrete, but of rough stones. Within two yards of the entrance lay the usual farm dungheap, so that the only air that could reach the inside of the byre and the dairy next door was polluted. To the eye of a sanitarian all at first seemed hopeless; but pointing to the filth-laden walls, the cobwebs of ages in the roof, and the slime of ages on the floor, I told my friend that there the mischief lay.

Passing outside into the pure Highland air which was sweeping up from the Souters of Cromarty, I relieved her mind by telling her the remedy was at her door, in that pure air which was Nature's antiseptic. The healthy animals in yonder field were mutely telling her what to do, and she had only to do it.

The sickly animals were consequently turned into a field by themselves and recovered, the dying died, the whole place was cleansed, disinfected, reformed, and no more was heard of sickness and disease.

It is not easy to see how the existing state of things can be improved until the farmer is sufficiently instructed to recognize first that he is the loser by his own ignorance, and secondly that his calling is one of great responsibility toward the public. If the landlord, instead of remitting so much per cent. on the rent owing to "bad times," were to assist the tenant farmer in the work of reform, it would go far to strike at the root of the evil, and bring more hope for better times in the future. Again, if the state were to extend the scene of its energies from the end of the track to the fountain head of the mischief, and either insist on reform or aid it, the influence would be felt not only directly on the animals and the produce of the farm, but indirectly on the health of man. It stands to reason that if only healthy animals left the farm, there would be less to fear from the spread of disease at the market place, and the discovery of disease at the abattoirs and meat markets. With disease playing havoc in our own country, it seems doing things by halves to guard our ports and leave our insular breeding grounds free.

To turn to the other side of the picture, it is pleasant to think in the midst of these depressing ideas that some of our large dairy farms have already adopted enlightened measures for preventing "milk epidemics" taking their origin in the farm.

When Pasteur was in this country about ten years ago he was taken to visit the Aylesbury dairy, which was the first to show the lead in this direction. He was extremely interested to find that the principles which had been already adopted by the advanced hospitals and breweries of the world had been taken up by this dairy, which was conducted from beginning to end in a scientific way: the farm being under supervision, and the milk being daily inspected by a scientific chemist, who was retained on the spot.

As it is now universally known that milk is one of the most subtile of disease carriers, there has sprung up a feverish anxiety among mothers to boil the milk. Failing better methods, this is the only wise precaution that can be taken; but in the boiling of the milk it should be remembered that certain antiscorbutic qualities are lost, which do not matter to adults, who enjoy every variety of food, but in infancy this loss is serious. In what is called humanized milk this element is also wanting, from the sterilizing or heating process it is subjected to, and if continued to be given beyond the earlier months of infancy, it leads to bleeding gums and other symptoms of scurvy.

Sir William Jenner, in one of his essays, asks: "Can we wonder that rickets is prevalent among the poor of London? Can we fail to wonder that geography, history, and crochet work form so large items in the instruction imparted at our national schools, and the doctrines of life so small an item? Let the girls there educated be taught that Constantinople is the capital of Turkey, if it be of any advantage for them to know it, but let them also learn how to dress, feed, nurse, and lodge an infant, so that it might run a fair chance of not swelling the amount of that truly awful column in the registrar-general's return—deaths under one year."

Considering, then, the dire effects of ignorance, it is surely time to ask when we may expect some of this practical knowledge to form part of the general education of the people. As I have shown, it is not enough to have professional inspection of food before it reaches the consumer, for poison of the most deadly kind may be generated in cooked and uncooked food through impure surroundings in the home. We may take milk from the purest source and yet cause agony and miserable health to our child by passing it through the familiar feeding tube, where the germs of putrefaction find a breeding place, and from which it is almost impossible to dislodge them. Hence from infancy to old age we are constantly the victims of our own ignorance; and this is all the more strange in an age of immense educational activity.

When we look around and see the countless houses everywhere, indicating so many homes presided over by women of every degree and in every station of life, it is deplorable to think of the domestic chaos which the lack of more practical education brings about. There is no doubt a movement in this direction, wisely favored by board schools and county councils, but merely to teach cookery and dairy work is not enough. We must begin at the beginning and teach the importance of cleanliness in the kitchen and in the entourage of the dairy, and direct attention to the penalties of neglect. To teach such things would be to excite in women a more intelligent interest in housekeeping, and make them realize the high place assigned to them in the order of Nature. To those who are intellectually disposed the art of keeping a house healthy and those within it in health might open up endless fields of interest, rivaling in mental exercise the more classical studies of Girton and Newnham.

When Napoleon the First was asked by Madam De Stael who was the woman he "most loved," his reply was "My wife;" but on being pressed as to the women he "most esteemed," his answer was "The woman who is the best housekeeper."*

To attain this art, then, in its highest sense, it is absolutely necessary to extend a wider and more practical education to women of every class; and it is only through this channel that women can hope throughout married life to retain at once the "love" of the husband and to secure man's lifelong "esteem."

ELIZA PRIESTLEY.

* St. Amand.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. AGRICULTURE.—Molasses Used as Cattle Food.—The feeding of cattle with molasses as now carried out in Germany..... 16149

II. ARCHÆOLOGY.—The Khmer Ruins of Siamese Cambodia.—The archæology of Cambodia.—Interesting remains of old time temples found there.—Remarkable effigies of Brahma.—4 illustrations..... 16148

III. ASTRONOMY.—Saturn's Rings.—The theory of the constitution of Saturn's rings.—Probable proof of their constitution recently accomplished by Professor Keeler of Pittsburg..... 16147

IV. CHEMISTRY.—Argon and Helium.—Professor Ramsey's lecture in Paris on argon and helium.—1 illustration..... 16145
Chemical Behavior and Use of Aluminum.—An examination into the action of different substances upon aluminum..... 16145
Composition of the Extinctive Atmospheres Produced by Flames.—By FRANK CLOWES, D.Sc., London.—A very interesting paper on the chemistry of flames, involving an analysis of the products of combustion.—1 illustration..... 16146
Isolation of Free Hydrazine, N_2H_4.—A very interesting achievement in the isolation of free hydrazine.—The method employed, the results and its properties..... 16144

V. CIVIL ENGINEERING.—The Long Island Water Basin.—Brooklyn's reservoir.—By A. N. BELL, A.M., M.D.—A very valuable review of the possible water supply of the city of Brooklyn and Long Island in general..... 16152

VI. EDUCATION.—Contributions to Science by Instructors.—By MARCUS BENJAMIN.—The role of the science teacher as original investigator and the work that has been done by them..... 16150

VII. ELECTRICITY.—An Electric Incubator.—An apparatus for producing fixed temperature electrically used for raising chickens and for the culture of bacteria.—2 illustrations..... 16149
An Electric Rudder Motor.—A storage battery electric launch with peculiar machinery for propelling.—3 illustrations..... 16149
Portable Electric Drills.—A type of electric drill with movable motor on truck to accompany it.—1 illustration..... 16149

VIII. HORTICULTURE.—Rockets.—An old time flower.—Its availability and method of cultivation.—1 illustration..... 16148

IX. HYGIENE.—Penalties of Ignorance.—The harm done by ignorance of hygienic precautions in hospitals, in families, and in the matter of food supply.—A most suggestive and valuable paper.... 16149

X. NAVAL ENGINEERING.—Induced Draught.—By Mr. W. A. MARTIN.—The use of artificial draught for marine boilers.—Its advantages and comparison of methods for carrying it out.—1 illustration..... 16151
Machinery of H. M. S. Magnificent.—Triple expansion engines for the new line-of-battle ship recently launched at Chatham, England.—3 illustrations..... 16151

XI. PHYSICS.—Projections by the Oxyetheric Blowpipe.—An excellent apparatus for magic lanterns, giving an intense light of small diameter of luminescent area.—2 illustrations..... 16144
The Slit of a Spectroscope.—By WILLIAM BROOKES, F.R.S.—An excellent article on a material for the jaws of the spectroscope slit.—2 illustrations..... 16142

XII. POLITICAL ECONOMY.—The Partition of Africa.—The map of Africa, showing how the great continent has been divided among the powers of the world.—1 illustration..... 16146

XIII. RAILROAD ENGINEERING.—Extension of the Paris-Sceaux Railway.—A description of the underground railroad in France.—3 illustrations..... 16145

XIV. TECHNOLOGY.—Improvements in Tanning Skins and Hides.—The use of hydrogen with arsenic for hides..... 16149
Radiant Tissue for Incandescent Gas Lamps.—By F. DE MARE, of Paris.—A new invention for the production of mantles for incandescent gas burners of the Welsbach type.—6 illustrations..... 16146
The Sand Blast Processes.—By JOHN J. HOLTZAPFFEL, Assoc. M.Inst.C.E.—A valuable article on this most interesting process.—Its capabilities and development.—The apparatus employed and its different uses, as for sharpening files.—8 illustrations..... 16150

CATALOGUES.

A Catalogue of Valuable Papers contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent *free of charge* to any address; also, a comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of authors. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *nearly fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Labels, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application, containing full information about Patents and how to procure them; directions concerning Labels, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases. Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 622 and 624 F Street, Pacific Building, near 7th Street, Washington, D. C.